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ABSTRACT

Techniques for science writers are outlined in a handbook designed to help research communicators define their field and to understand better the world of the researcher. It is argued that the public appetite for news about science is considerable and that the public's understanding of science would be fostered through collaboration among researchers, writers, editors, and media professionals. Topics discussed include: the national importance of communicating university research, a public view of science and research, agricultural research, the need to communicate scientific background and not just the new, the emphasis on results instead of the problems, medical research, engineering, computers, journalism, controversial science such as alcohol research and nuclear power, literacy in mathematics, language efficiency, the press conference, science writing for newspapers and television, science magazines, the science writers' network, the scientist as newsmaker, and journalistic credibility and institutional interests. Appended supplemental readings include: "Readership and Coverage of Science and Technology in Newspapers and Magazines: Report to the Council for the Advancement of Science Writing" (Sana Siwolop): "Gene Cloning by Press Conference" (Spyros Andreopoulos): and "Science Writers at Work" (Sharon Dunwoody). Annotated reading lists and other resources are appended. (CC)

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COMMUNICATING UNIVERSITY RESEARCH

Edited by Patricia L. Alberger and Virginia L. Carter

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INTRODUCTION

Nuclear power...arms control...energy...research on DNA. All require broad public understanding of science if citizens are to influence wisely the decisions of their elected representatives and of other policymakers. A major part of the research on these topics--and others of equal importance--takes place within American universities. The extent and importance of this research are shown by the fact that federal support for university research reached an estimated $5.5 billion in 1979.

All too little information about this activity reaches the public. The gap exists, in part, because university news writers and periodical editors lack a background in science. Most of these writers and editors studied the arts and humanities, not science and engineering. They are ill at ease and frequently ineffective in covering stories about research. They are unable to "translate" with clarity and accuracy the language of the scientist into the language of the newspaper reader or radio listener. Even when they have excellent stories to tell, university writers and editors often do not know the best outlets for them.

A group of research communicators within CASE began in 1977 to urge CASE to take a more active role in research communications. Encouraged by a grant from the Public Understanding of Science program of the National Science Foundation and by the cooperation of five other associations, CASE held in October of 1980 a major national conference on communicating university research. This handbook is an outgrowth of that conference.

In our proposal to NSF, we indicated that CASE would indeed make a major commitment to the encouragement of better research communication. We have done this. We have added categories in this field to our Recognition Program. Many of our districts are sponsoring sessions at their conferences on how to tell the research story. Research editors have formed an informal network, with CASE encouragement. And we are planning a second national conference in the spring of 1982.

None of this would have happened without the initiative of a small group of talented people. They prodded, encouraged, and helped me get these projects started. All university research communicators owe a debt to:

William Kell of the University of Minnesota, the leader of the group;

Robert C. Anderson, University of Georgia;

Blanchard D. Hiatt, University of Michigan;

Earle M. Holland, The Ohio State University;

George C. Keller, University of Maryland;

Paul D. Lowenberg, University of California, San Diego;

Carol L. Rogers, American Association for the Advancement of Science.

Also important was the active support of five associations: the American Association for the Advancement of Science; Association of American Universities, Council for the Advancement of Science Writing, Council of Graduate Schools in the United States, and National Association of State Universities and Land-Grant Colleges. George Tressel and Jean Intermaggio of the NSF Public Understanding of Science program also have our thanks for their moral support and for the pivotal grant from NSF.

Finally, our thanks to Patricia Alberger, who has patiently and efficiently shepherded this handbook. She has overseen it from the stage when the conference talks were on audiotape until the edited, proofread, author-approved final manuscripts went to the printer.

The writers in this handbook do more than outline techniques. They try to help research communicators define their field and to understand better the world of the researcher. At the conference, we established in miniature the environment that will best foster increased public understanding of science: a close collaboration among researchers, writers and editors, and media professionals. It is to that collaboration that we dedicate this handbook.

Virginia L. Carter
Vice President, CASE

June 1981

TABLE OF CONTENTS

SECTION ONE: COMMUNICATING UNIVERSITY RESEARCH

Plural Publics

The National Importance Of Communicating University Research page 1
Jean Mayer

How The Public Views Science And Research page 7
George Tressel, Rae Goodell, Thomas H. Moss, William Stockton

Research Magazine--A Nuts And Bolts Account page 27
William R. Kell

Reaching Client Publics page 38
Delbert P. Dahl

Researchers' Reflections

The Problem of Informing The Public About Basic Research page 52
Victor F. Weisskopf

University Research: Medical and Life Sciences page 60
Richard Johnson

Applied Sciences: Engineering, Agriculture, And Computers page 69
William P. Flatt

Journalism, The Academy, And The New Class page 76
Michael Novak

Coping With Controversial Research page 83
Robert DuPont

Making The Arcane Plain page 93
Lynn Arthur Steen

Translating The Curious Languages Of Research page 100
Jon Franklin

On the Research Beat

Informing The Public About Research: The Media page 109
David Perlman

How I Cover Science: Newspapers page 116
Cristine Russell, Warren Leary, Patrick Young

How I Cover Science: Radio/TV page 128
Edward J. De Fontaine, Robert Bazell

How I Cover Science: Magazines page 140
Susan West, Allen L. Hammond

The Gatekeepers: The Inner Circle In Science Writing page 152
Sharon Dunwoody, Ben Patrusky, Carol Rogers

The Scientist As Newsmaker page 162
Rae Goodell, Cristine Russell

The Genuine Article: Reporting Real Research page 171
Warren Leary, Susan West, Patrick Young

Serving Two Masters: Journalistic Credibility And Institutional Interests page 179
Allen L. Hammond, Paul Lowenberg, Robert Bazell

Mediating the Message

Universities And Information About Research: The New Agenda page 189
George Keller

SECTION TWO: SUPPLEMENTAL READING

Readership And Coverage Of Science And Technology In Newspapers And Magazines: Report To The Council For The Advancement Of Science Writing page 197
Sana Siwolop

Gene Cloning By Press Conference page 206
Spyros Andreopoulos

Science Writers At Work page 209
Sharon Dunwoody

Suggested Reading List page 217
William R. Kell, Robert J. Fauteux, David S. Miller

For Additional Reading . . . page 222
Sharon Dunwoody, Joye Patterson

Other Resources page 226

SECTION THREE: MICROFICHE

Talking Sense About Science
William D. Carey

Tailoring Science Writing To The General Audience
G. Ray Funkhouser, Nathan Maccoby

Should Scientists Be Involved In Science Writing?
Rae Goodell

Research On Science Communication: What Is Known And What Needs To Be Known
James E. Grunig

The Scientific Literature: Can We Keep It from Ruining Science?
H. L. Lentzner

The Scientist's Responsibility For Public Information
Neal E. Miller

Editing Science Articles Isn't Different...Or Is It?
Elise Hancock

Turn On To Science Writing
Earle M. Holland

SECTION ONE:
COMMUNICATING UNIVERSITY RESEARCH

Communicating University Research: Plural Publics

THE NATIONAL IMPORTANCE OF COMMUNICATING UNIVERSITY RESEARCH

Dr. Jean Mayer
President
Tufts University

Perhaps one of the most neglected aspects of science reporting is not the reporting of the discovery of new facts or even new ideas, but the discussion of the impact on society of important new facts. It is easier to write about a new fact discovered by a professor or a university laboratory--and we feel safer doing so. It is more difficult to report on concepts and ideas that a person or a group has developed about a problem based on science and technology. Very often one has to extract that type of information from a scientist rather than serve as an effective transmitter for a scientist who has found something wonderful at 11 this morning and is eager to tell the world about it before lunch.

The appetite for news about science in our public at this point is considerable. I think the fact that The New York Times science section is apparently the most popular of all the newspaper's supplementary sections illustrates that. The growing number of new scientific magazines and the continuing success of Scientific American are other examples illustrating the fact that we have a large public interested in science. How well prepared our public is to understand science is more difficult to evaluate, especially as science grows more complicated.

As I spend more and more time in universities, I am continually impressed with how crucial the role of the high school is and how in American universities we are driven to construct programs that follow what is certainly the weakest part of our national educational system, namely high school education. I think reinforcing the science curriculum in the high schools will go a long way toward creating a public that is more versatile in its understanding of science, and this is something we should all look at very carefully. The general education courses in the colleges in the sciences are certainly an improvement of what existed before, but still don't make up for the lack of a strong high school curriculum. You may remember that President Conant lauched at Harvard the first general education courses of that type because he had been so horrified at finding out that President Franklin Roosevelt, a Harvard graduate, had not had a single course in the sciences before he became President. He had had some mathematics at Groton, but he had never had any physics or chemistry. The problem of explaining to someone with that degree of scientific literacy why in the middle of a very exacting war two billion dollars should be diverted to build an atomic bomb was something that he felt no scientist should ever have to face again. We have improved since those days, but not enough. When dealing with a society based as ours is on science and technology, our population's lack of general science literacy is a major problem that should be corrected at the high school level before it must be dealt with at the college level.

The second major problem is that we don't teach people very well who is an authority on what, and how you distinguish who is an authority on what. This is aided and abetted by two phenomena that are related to one another. On the one hand, many of our colleagues in the sciences are timid about departing from the tiny area in which they feel secure and in which they are experts. So when they are asked questions on subjects to the right or left of their specialty, they won't talk about these topics because they are not in "their field," even though they know enormously more than most in that particular area and obviously more than the general public knows. By contrast, you have people who have lost the sense altogether of what is not their field. I think we all have in mind a number of scientists, one of them a recent Presidential candidate, who remind you of what Voltaire said about somebody who knows everything--that is all he knows, but he knows it very well. The mark of an educated person is not that he or she knows everything, but that he or she has a good idea of how to find an expert on a given area and knows what degree of credence and credibility to give to various bodies.

The situation hasn't been made easier by scientists' lack of perspective as to their place and their knowledge as compared to general knowledge. I think it is probably a deficiency in our educational system that people lack either the assurance of being able to draw broad conclusions in fields related to theirs, or the necessary timidity not to speak about subjects they know nothing about. It reminds one of Abraham Lincoln's saying: "There are times when it is better to be thought a fool by saying nothing than to speak out and remove all doubt." One good example of where timidity would have been the better part of valor is in my own field--the recent report of the Food and Nutrition Board on diet and degenerative diseases, which was an absolutely scandalous document read by most of the cardiac patients in this country. The report was read by cardiac patients as meaning that they didn't have to worry about cholesterol anymore. An eminent thoracic surgeon at Tufts told me that in one day following this report he had seen 14 consecutive patients with coronary bypasses who had gotten off their diet because they had read the report. The report in this case was self-conceived; nobody had asked the Food and Nutrition Board to write it. As you know, the Food and Nutrition Board is a creature of the National Academy of Sciences. Membership is rotating, and at that time it was composed of a small group of individuals with very narrow backgrounds. There was not a cardiologist among them, there was not an epidemiologist among them, and there were several people on the Board who had been riding certain hobby horses for years. The principal author of the report was a well-paid consultant for the National Egg Board, which leads to all sorts of interpretations.

What is especially alarming is the way in which the report was immediately publicized by the media--with disastrous effects for preventive medicine and curative medicine in this country. We are in this particular case dealing with the most prevalent of all fatal diseases in the United States. It is interesting that in this particular case congressional hearings, more than journalistic efforts, exposed the report's limitations and the possibility of corruption regarding this report. This is obviously a

situation where the public was and is confused, It clearly points out the lack of understanding of science's limitations, the lack of understanding of what various disciplines do, and for that matter the lack of education among the public and scientists as to the difference between preventive and curative medicine. This was a very serious example of the writing of a popular report and its coverage by the media that were both counter-productive. This is also a situation in which the impact of science on society was not thought through by the scientists and not covered properly by reporters. There are many examples that are perhaps less obvious.

A number of people who have reached a certain age in science find themselves members of several advisory bodies to the government where they feel they have various degrees of competence in terms of the advice they may give. This is one reason I have thought very seriously recently about who is an expert on what and what sort of expertise one can bring and report on. I have been vice chairman of the Presidential Commission on World Hunger, an area of science and technology and society where no one can hope to know everything on a subject that complex, but where I feel as well prepared as anybody to give advice because I have worked in this area for years. However, I also find myself in two other situations where I am less confident and where I am very dependent upon what I read in newspapers and magazines. I am on an advisory committee to the Department of Energy, and I am a science advisor to the Secretary of State. In both situations I think I was selected because of a certain competency in an area, let's say the energy cost of the food supply or the problems of food and nutrition. But those committees have very few scientists on them or are very small. Therefore, we are asked to give advice on a great variety of subjects about which we then have to find the information. This is where I have a chance to really measure the limitations not simply of the reporting of facts, but the limitations of interpreting facts.

In a sense, my problem there is no different from that of every other citizen trying to decide on such science subjects. The Department of Energy is perhaps more than any other department of government at this point engaged in planning the face of things to come. It takes a very long time to explore and find new deposits of fossil fuels. At this point it takes an enormous amount of time to plan any type of power plant, particularly a nuclear plant, and it takes a great deal of time to decide that we are, for instance, going to change certain types of agricultural practices throughout the United States. This department is making decisions now that are likely to influence what is going to happen 10, 20, 30, or more years from now. And yet the decisions are made on the basis of facts that I can't find and on interpretations that I can't find. For example, France has contributed more to the development of atomic energy than any other country, except the United States. The French at this point are opening an atomic plant every two months; and they are opening breeder reactors. I had a chance to talk to the French prime minister last year about this topic and he told me he had two problems. The first one was that the people at both the extreme right and the left thought the government was going too slowly in the development of atomic energy. His other problem involves foreign policy.

At a demonstration against nuclear power plants, most of the demonstrators were West Germans. His problem was to make sure that the police didn't get carried away with their enthusiasm about showing young Germans that they could not come to France and tell the French what to do and what not to do. But basically, he had no problems of public opinion in France, and only a problem of moving faster in developing a gigantic program of atomic energy, which means that most of France's energy installations are going to be atomic by 1990. They believe they have dealt with the problem of radioactive residual disposal by the technique of vitrification, which means they make glass out of it. They are sufficiently confident about their technique that they put radioactive residues made into glass cylinders in underground areas where they can be retreived eventually and used as raw material for industrial applications. Now surely we ought to have a discussion in our media as to whether these people are mad, or whether they have a technique that really works, in which case we should immediately adopt it and move ahead. The implications of the energy policy in the United States affect the whole economic development and employment situation. The fact that I have never seen a serious discussion of the enormous differences in perspective between the Americans and the French seems close to a national scandal. Obviously, it is very difficult to advise the Department of Energy about what to do concerning this major practical alternative to fossil fuels at this point.

There are other examples of the sort of problems one encounters in energy policy. The estimates of how much natural gas we have in this country vary by close to a hundred fold between agencies of government. The U.S. Geological Survey estimates gigantic amounts of gas, which it says no one has ever looked for because the price of gas was much too low and gas was found only as a byproduct of looking for oil. But if the U.S. Geological Survey is right and the Department of Energy is wrong, then obviously we ought to put our money into finding that gas instead of spending a hundred million dollars on synthetic fuels, largely to make gas out of coal with enormous ecological problems involved in the process. Now there are differences in interpretation and there are differences in estimates of costs, but surely this should be a point of national discussion because it is far more important than a lot of the other problems we are being presented with.

Another example is gasohol. The government is moving ahead very rapidly, and actually plans for large scale production of gasohol. We have had some discussion, particularly in science, but we haven't really had the type of national discussion we ought to have as to whether this is a good idea or whether it is a tragic mistake. Superficially it looks very nice--we are using renewable resources; we are going to make farmers more self-sufficient regarding energy; we are going back to the ideal of Jeffersonian democracy; and it is going to free us from dependence on fossil fuels. What we are not told, what we are not discussing seriously, is the fact that most methods of manufacturing gasohol presently contemplated in the United States do not create any net energy gain. The cost of growing the grain in terms of petrochemicals for power, for fertilizers, for pesticides, for distillation, and for fermentation is about

the same as what you are going to get back in alcohol. So you are not producing energy; you are simply conceivably making yourself more independent of imported oil. The political aim may justify this, but most people think that we are talking about energy generation. What is perhaps more important and more serious is that just because a resource is renewable doesn't mean that it is without cost; in this particular case the main cost is that of erosion. In order to produce gasohol from grain we would press into service a lot of land that is not only very expensive in terms of energy, but land that is marginal because it is very easily eroded. We have a massive problem of erosion in the United States, not quite comparable to what we had in the thirties, but which is again much greater than what we had in the fifties and sixties. If we put the land into cultivation we are going to lose a lot of top soil, and we haven't really thought the thing through. Finally, we are at this point talking about converting grain into alcohol in a period of relative abundance of grain for the world at large. But if we should again find ourselves in a position similar to that of 1972 and 73, when we had grain failures in various parts of the world, and if we have an enormous investment in continuing to convert grain into power, the American grain reserves that saved the world from massive famine in 1973 will no longer be available.

All these things ought to be discussed before we develop an energy policy. My point is that we are dealing with perhaps the single most urgent of all our economic problems. The problem of energy policy is not so much an ignorance of the basic facts as it is a complete lack of serious discussion of what the alternatives and the costs are, and of what is being done elsewhere. If this discussion is not maintained by science reporters or by journalists with an understanding of science, it is just not going to be held.

The answer to this problem is not a particularly easy one. I suggest that the role of the science communicator for a college or university ought to be much more than taking a professor's paper and translating it into a language the layman can understand. Or even doing what I'm sure many of you do--go from door to door and try to stimulate some of the articulate scientists to speak in terms that non-scientists can understand, to describe what they are doing so that a nice article can be written about their research for the facts they have just found. I think we need a great deal more think sessions involving perhaps several scientists in the same field. These can then be recorded to explain to laymen throughout the country the implications of present day work.

I am fond of saying that we live in the most exciting period in the history of the world in terms of science. In the lifetime of many of us we have unleashed atomic energy, with fusion around the corner. This may at some point provide almost unlimited amounts of energy, and what does that mean? We have escaped gravitation and started exploring the solar system, and this may be the beginning of transmission of life to other worlds. We are witnessing the computer or data-processing revolution, and the implications for society I think are not totally understood by most of our fellow citizens.

I think it is important to look at the economic life of this country in this way: About 3 percent of our people right now are farmers or engaged in agriculture; 18 percent are engaged in manufacturing; and everybody else is engaged in processing and transmitting information. If you look at the statistics showing the amount of silicon produced in the United States, you will see that it is absolutely exponential; it is almost a vertical line. We can now put 64,000 bytes of information in a computer and will soon be able to put in 256,000 bytes of information. The amount of information processed through computers is of a completely different order from what it was 10 years ago.

And finally, I think there is not enough understanding of what is happening in the genetic revolution through genetic engineering. Because I am interested in the world food supply, I have had the privilege to see both in the United States and in Europe in the past few months hundreds of entirely new varieties of rice, corn, and wheat that have been produced through genetic engineering and did not exist before. I have already seen a number of new plants that didn't exist before. We will very soon see new animals as well as new plants, and we will see new people. As you know, the work on genetic engineering in man has started. This means that after five million years of being the products of natural evolution we have now seized control of evolution and can be the engineers of future life.

All this has tremendous societal implications more distant and more important than the particular facts cited before in medicine and in energy, which are important enough. Unless we can make science and university reporting more than the reporting of new facts and even single new ideas, unless we can really transmit to the public what the university should be about and not always is--a place in which ideas are discussed and implications of new facts on society are described--, we will really have failed in one of our most urgent and important tasks.

HOW THE PUBLIC VIEWS SCIENCE AND RESEARCH

George Tressel
Program Director
Public Understanding of Science
National Science Foundation

Dr. Rae Goodell
Assistant Professor of Science Writing
Massachusetts Institute of Technology

Dr. Thomas H. Moss
Staff Director
House Subcommittee on Science, Research and Technology

William Stockton
Science Editor
The New York Times

GEORGE TRESSEL

It is rather distressing that a meeting of this kind is so unusual, and that there are so few times that the representatives of science who are concerned with public information gather to share experiences and compare problems. Despite the size and importance of the research and development industry, there is no organization of science public information staffs. It seems to me that it is about time we started to have meetings like this, where people concerned with the public communication of science, especially those within the research establishment itself, begin to work together and consider what we can do about the general understanding of science.

It is common to talk about the need for greater public understanding and greater science literacy among the public. And that is really what public information should be all about. Our role in life should be more than trying to get more public approval, more funds for our particular laboratory, or serving as a "flak" for the latest laboratory promotion. There are much more important things for the public to understand than how many thousands of dollars so-and-so got for his or her latest project.

Public understanding of science is like the weather--everybody talks about it. The scientific community delights in discussing how little the public knows and how important it is to have better public understanding of science. But, in fact, few members of the scientific community are willing, able, and committed to doing anything about it, except to complain.

To follow the same metaphor, the wind is blowing in our direction right now. There are dozens of new science magazines, and the circulation for most is growing at about 15 percent a year. Science museums attract almost as many people as all other museums put together. "Universe" will

be on the air next year and the audiences for shows like "Cosmos" and "The Body Human" are very substantial. And 10 percent of the AAAS fellows are hired by the organization where they intern. All in all, the outlook is quite encouraging.

But before we become too enthusiastic about this progress, we should consider some underlying questions that are important, pervasive, philosophical, and have long-range implications.

For example: What's the difference between public understanding and public appreciation? When most scientists or research workers talk about public understanding they really mean public appreciation. However, spokesmen for the science and academic communities should really be concerned about something more important than "selling the product." If people understand your work, they can figure out for themselves whether to appreciate it. We ought to have enough confidence in the public to believe that, and enough confidence to act upon it.

If our activities are truly important and worthwhile, then there are more important things for public information people to do than simply to write and distribute science anecdotes. While we're doing this day-to-day activity, we need to remind ourselves of the reasons for and the goals of science communication.

One can communicate science on a variety of levels and to a variety of audiences. Generally the scientists we work for don't recognize that there is a difference between talking to a member of Congress, a governor, or a state legislator--the so-called decisionmakers--and the person who views "LaVerne and Shirley." What's the difference between them and what should we say to each one? What do they need to know? How do we decide what message to send--and where--and how should we package it? How much depth should we provide? Whom are we trying to please? Are we trying to reach a lot of people? Or are we trying to please the scientist by putting out a nice press release about him or her?

There is a broad spectrum of public understanding and there is a great difference in the kind and quality of material that is needed. At the low end of the spectrum there is a simple need for awareness of what science is, where it fits, and what it's doing.

At the other end of the spectrum, there is a much smaller (less than 25 percent) portion of the public that is motivated, sophisticated, and generally attentive to the activities and issues of science. For these people there is a need for much more substantive discussion of the issues and implications of science.

Essentially this means that three out of four people really don't care about science-related issues. We do. But they don't. Probably at the present time the one attentive person is pretty well served. We have many new science magazines, plus innumerable science house organs. The more urgent question is: What can and should you do for the other three out of four people who had hardly heard of radiation before Three Mile

Island, and who are increasingly forced to think about things like Love Canal, laetrile, recombinant DNA, and acid rain without even a minimal background in biology and chemistry?

How can we motivate their interest and gradually develop the broad background that is needed to understand the importance of science today? Only after you have thought through this question and have some picture in your mind of what we're trying to do is it possible to discuss the methodology intelligently.

RAE GOODELL

My job is to share with you some of the major research findings that shed light on the supply and demand of science news. What does the public want, and what does the scientist provide? Of course, much of what is important in science communication happens in the intermediate stages--between the supply at one end and the demand at the other--in the work done by public information specialists, science writers, and the like.

First, on the subject of public interest in science and science news, the data for the past 22 years have been consistent and encouraging. The audience for science news may not be as large or as enthusiastic as we may have hoped, but it is far better than we had feared. Science almost always fares well in readership surveys, for example. When survey respondents are asked to rate their level of interest in headlines, news categories, or news stories, science, medicine, social sciences, and environment end up with scores roughly in the same league as any other major subject such as consumer news, foreign affairs, and education. This has been true since the 1950s, when the National Association of Science Writers conducted its studies, and it was still true in a major Canadian government survey in 1975, a Newspaper Advertising Bureau survey in 1977, and in Gannett and National Science Foundation studies in 1979.

Most of these surveys also find that 25 to 50 percent of respondents express a need for more coverage of science. This is not to say that science is universally adored. There is a galloping case of public apathy toward science, but the disinterest in science is no more prevalent than the disinterest in any other political area, as Jon Miller of Northern Illinois University and his colleagues have pointed out.

In this era of information overload and excessive demands on people's time, Miller and his colleagues contend that many people elect not to follow public affairs at all and that those who do follow them select just a few issues to follow closely. There is what Miller calls a small attentive public, as George Tressel mentioned, for any policy area, including organized science. People involved in prison reform, agricultural policy, and saving endangered species feel equally neglected.

On a brighter note, in an analysis of responses from a public survey of 1,635 adults just completed for the National Science Foundation, Miller

and his colleagues estimate that nearly half of the public are "regular consumers of organized science information" in the mass media. That is, they regularly use a combination of general and specialized science information sources.

Nearly half of the group--not necessarily the same half--also demonstrate a high level of interest in science stories, as indicated, for example, by expressed interest in headlines in the area.

As in past surveys, the consumers of science news in the new NSF study are likely to have relatively high levels of formal education; college-level education particularly is a predictor of science interest. And the consumers are likely to be male. It is interesting that the market for science news among women has never really been explored.

The NSF study also finds that more people profess an interest in science news than have found their way to specialized science media, such as shows like "Nova," "Ascent of Man," museums, and so forth. Presumably, this gap between interest and consumption is the market now being explored by the popular new science TV shows and magazines.

One thing that is not clear is whether the public wants to hear more about political issues and controversy in science or about research and development. Newspaper editors have been opting for conflict, and the percentage of conflict stories has jumped in recent years. On the other hand, many of the popular new science magazines are going more for the old "gee whiz" approach, emphasizing the promise of research rather than its problems. Cynically, we could speculate that the magazines are picking up on the advertising dollars the newspapers lost by being too controversial about scientific and technological industries.

To sum up, disinterest in news is not special to science, and there's no justification for giving science less press attention than any other area of political and social life.

If not apathy, then is there not an outright hostility toward science in the public? If one looks at the image of the scientist in popular culture, it would seem so. The scientist is frequently pictured as a crazed cartoon character, a white-coated aspirin peddler, or a bungling cloner turning innocent bystanders into incredible hulks.

However, according to surveys, all of this has had relatively little impact on the more serious side of public opinion. A decade of NSF Science Indicator Surveys--plus those by the National Assessment of Educational Progress, Union Carbide, Harris, and others--have failed to turn up any major anti-science sentiments. Attitudes were fairly constant and generally positive. Typically, 60 to 80 percent of respondents agree with statements to the effect that science has brought us more benefits than problems or that it has improved life.

There is some distrust of certain aspects of science measured by respondents' agreement with statements that science causes change too rapidly,

creates dependence on machines, and the like. But apparently, most respondents see a distinction between science and technology, and they place the blame on technology, however they define the difference.

Also, in spite of wariness about developments in science and technology, the practitioners--the scientists and the engineers--are still held in high esteem. And as in the case of public apathy, the hostility that exists is not peculiar to science and technology. It is a reflection of larger social forces. There is a general decline in confidence in social institutions in this country, according to an analysis by sociologist Amitai Etzioni and others. Although science also has slipped in public confidence, the decline is slight, and science is holding its own very well. As social institutions go, science still receives public confidence second only to medicine and higher than religion, the Supreme Court, education, and the press.

So, from the public we have extensive demands for science news, in spite of general political apathy, and sizable confidence in science as a social institution, in spite of a general decline in that area.

What comes from the other side--the scientists--in response? That depends in part on what happens within the powerful system of social control operating in the scientific community. Within that system, as sociologists have documented, various forms of recognition--good positions, awards, invitations to meetings, trips to Europe, promotions, and so forth--provide incentives to keep the research enterprise in high gear. Such a system is going to be hard on activities that compete with research for the scientist's time.

Relationships with the press, in fact, are a special problem for scientists because the social system has not yet evolved a consistent position on popularizing science: Is it desirable or isn't it?

Adding to the scientific community's internal confusion, external political pressures are also conflicting. For example, events in the 1960s, such as the Vietnam war, and events in the early 1970s, such as the tightening of Federal research budgets, encouraged what was called a social responsibility movement in science. However, traumatic events in the later 1970s, such as public response to recombinant DNA, encouraged a backlash against communication with the public.

One can visualize scientists in the proverbial pyramid. At the bottom is a broad base of scientists who are rarely heard from, not necessarily because they are sullen and hostile, but more likely because they're uninterested or uninteresting. Next are the many scientists, including most elite university scientists, whose research occasionally becomes newsworthy for a short time. Closer to the top are the regulars, the inner group of sources who comment on research and technical disputes within their specialties or close to them. Still higher up the pyramid are the scientists who speak out frequently to promote and to criticize broad areas of science and science policy--the university administrators, Washington bureaucrats, consumer group leaders, and so on, who are

involved in issues they feel need public response, either in the form of support or intervention. Finally, at the top of the pyramid are the few scientists who are sufficiently motivated, quotable, colorful, credible, and accessible to become celebrities or visible scientists.

The problem with the pyramid model is that a pyramid seems solid and dependable. In fairness, we should turn it upside down. This would convey a better sense of its instability, as well as a sense of the weight of responsibility for communicating with the public that rests on a few scientists at the point.

If there's one theme most prominent in studies of the press coverage of science, as I analyze them, it is that science news relies on too limited a group of scientists, those regulars at the narrow end of the pyramid. The criticism is that the press passively accepts the views of these few scientists as authorities, rather than actively seeking out a broader spectrum of perspectives and opinions. All too frequently, even in highly subjective areas, it is considered enough to juxtapose one scientist's statement with one critic's response, creating an arbitrary balance and ignoring the whole range of viewpoints in between. The result is that the press often misses stories that are not framed in terms familiar to the established scientific community, such as the ethical implications of research, and stories that are perceived as threatening to the security of the community, such as laboratory safety problems.

I'm not sure it makes sense to ask scientific spokesmen to stop trying to push their point of view, foster a favorable public image, and rally public support, any more than we would ask the oil industry or presidential candidates to do so. That's their job. But it's not the press's job, and, in fact, the press's passive reliance on a limited group of scientific spokesmen has caused serious gaps, according to researchers and observers of the coverage of Three Mile Island, swine flu, marijuana safety, DES, recombinant DNA, asbestos, the Apollo flights, and the war on cancer. I can add to the list the example that Dr. Jean Mayer has pointed out--coverage of the Food and Nutrition Board's report on diet and cardiac disease. It was not the press, but Congressional hearings on the subject, that brought out some of the problems with that report.

In study after study, the message comes through: If more reporters would seek out more sources, science news would improve. Fortunately, observers have also suggested some ways that public information specialists might help the situation.

First, for the broad base of scientists who rarely deal with the press, such encounters are uncomfortable and sometimes create intense ambivalence and anxiety. When a scientist's work suddenly draws press interest, therefore, why not supply moral and logistical support, perhaps extra telephone service, extra secretarial support, and some counseling on media relations to offset some of the objectionable side effects of media attention? Journalism professor Charles Eisendrath suggested such an approach after looking at the striking lack of information reaching local reporters about recombinant DNA from the University of Michigan.

With regard to the next level of scientists, those who are regular sources, the main problem is to generate more of them with a broader range of opinions. A number of observers have urged that public information officers hold "backgrounders" or briefings in potentially newsworthy areas, particularly those with broad social implications. These backgrounders would be for general reporters and for editors, as well as for science writers. The most important function of those briefings, I believe, would be to expose journalists to a greater variety of sources that they could call upon later.

Finally, to end up at the narrow end of the pyramid, these days a scientist has to be an egomaniac, a cantankerous eccentric, or a missionary. Public information people must join science writers and scientific leaders in creating a climate in which more moderate folks can be comfortable doing extensive popularizing of science. This means injecting into the social system of science significant rewards for popularizing, such as fellowships for studying popular writing in universities--fellowships, in other words, for writing aimed at the public, rather than at other scholars. Other rewards might be prestigious awards for jobs well done in the area and special positions where job security is based on popular, rather than technical, publications. These are a few suggestions based on my interpretations of research in this area.

WILLIAM STOCKTON

I'm always fascinated to hear Rae Goodell's research about science writing. There is another kind of research: the mail we get. We get a lot of letters, and I want to share a few of them with you because they sound a theme.

> "To the science editor: According to Dr. Ernest Sternglass, nuclear radiation is responsible for a decline in SAT scores. One wonders why school children in Japan, a country that has been more devastated by fall-out than any other, do better on similar tests than American school children do. Is it that low-level radiation given off by a government-owned bomb is relatively harmless, but radiation tainted by greed isn't? Or could it be that the nuclear fall-out question is the fall-out of nonsense from the anti-nuclear movement?"

We ran a piece about differences in the male and female human brain. And we got this letter:

> "I'd be the first to agree that human male and female brains show sex differences if the automatic corollary is agreed upon: That the male of the species is by nature violent, untamed, and sick, therefore inferior to the female."

A story about cockroaches that appeared on the front page of "Science Times" turned out to be one of our most popular stories and evoked more mail than anything we've run. Here's a sample:

"To the editor: Reference to your February 19th article about cockroaches: To slow a cockroach so that you can deliver a lethal smash to the little beast before it scoots, administer a squirt of hair spray. Any brand will do, provided you keep an uncapped can in every room where it can be grabbed blindly and used pronto. Roaches don't tarry. Lord knows what hair spray does to hair."

Here's another one:

"Your recent article under the science section expressing evolution as being scientific should be noted as being erroneous and inaccurate. It is a well-known fact of biology that changes in living things are genetically limited. For example, there are various races of cats but such variations are within the limitations of the cat kind. Gene combinations can only occur within a kind and not across kinds. Mutations which have been used as an argument for evolution are, by nature, random, almost always harmful, and can only work within the framework of the laws of genetics. Mutations are merely random changes within the existing structure of genes. They cannot create new information in the DNA molecular code....

"Finally, it should be realized that the skulls that are presented as evidence for evolution are misleading. Many of these skulls are incomplete and can be reconstructed by certain angles to appear in a variety of forms. Evolution is a mere hypothesis that is unjustifiably presented as science."

Another one reads:

"To the editor, Science Times: It is fairly clear from Jane E. Brodie's article on obesity and diabetes in the Pima Indians that the cause of these problems was the influence of Father Kino, who succeeded in changing the character structure of this people in such a way as to provide an increase in the secretion of gastrin. Yet it is typical of the physiological tunnel vision of our times that such a mechanism is not even mentioned in the article.

"Of as much interest as whether there is a genetic basis for the Pimas' problems would be whether Father Kino, himself, was highly obese, which would suggest that these Indians dealt with the loss of him during his year of absence by a mechanism of identification.

"There are two questions about the Pimas' problems from a genetic viewpoint. Is there a genetic-based tendency to hypersecrete gastrin? Two, is there a genetically based increased risk of diabetes among the Pima Indians in the presence of obesity? However, any attempt to understand the cause of the Pimas' problems is bound to fail unless it takes into account

that tribe's attitude toward life, an attitude that was apparently changed by Father Kino in a way that produced increased frustration of certain oral tendencies that may have been more fiercely expressed prior to his coming."

This is signed, incidentally, by a medical doctor.

One woman writes frequently, and she talks about several stories in one letter:

"As long as I am writing you, I have two more complaints.

"The first is about the short, ridiculous review some time ago of the marvelous Channel 13 program on spiders. It must have taken years to study the subject and more years to organize and photograph. The photography was superb and beautiful. The program was not only educational and worthwhile but also beautiful visually. Not everyone dislikes spiders. I, for one, consider them intelligent, beautiful, and useful. To write off years of research and dedication with a few snide remarks is unworthy of a paper like yours.

"Secondly, the article about stagefright.... Stagefright should not be treated with drugs, as suggested in the article. Get to the root of the matter. If the performer, be he entertainer, musician, or speaker, is convinced that he has a message it is important for his audience to receive, a message which will benefit the audience, he will forget himself and lose his stagefright.

"P.S., I'm a long-time subscriber who's considering letting my subscription run out because your paper has become unwieldy with a whole section on food every week and lots of unimportant, silly space fillers."

Finally, here's a postcard we received:

"Are you aware that school children are clipping articles for science projects? How about keeping that in mind when laying out an issue?

"If two articles are printed back-to-back and they have no access to a copy machine, they are forced to cut through one article and lose its use. Maybe you can put articles on page one, advertisements on page 2, etc. You are the expert; you figure it out."

I went through a whole file of about 100 letters, and they're all like this. I was struck at the end that, while the letters are funny and we can laugh at them--and they didn't get published for that reason--they do reflect a recurrent theme: that science and technology can solve our problems but don't seem to be doing it. A DC-10 airplane falls out of

the sky, New York City subway cars are being recalled, new buses don't work, and nuclear reactors are having problems--the list goes on and on.

People are concerned that things aren't working and want to know what can be done about it. That's why they want to know about science. They want to know about things that touch their lives, that mean the most to them.

I had lunch one day with a person from The New York Times research department. We have a very large department that studies what readers want. The staff doesn't do it because we editors want to know that; it does it because it wants to sell advertising. And there's a divided school of thought about this research among the editors. Some people feel we should shun the researchers because to find out what the public prefers to read and what its opinions are about things is to sully the editorial process, which should be pure and pristine. And there are people who are very serious about that.

There are others, and I think I'm in this camp, who think it would be interesting to know this. But at the same time we recognize it's a dangerous piece of information to have because it begins coloring what we give people. To what extent should we give people what they want? What is our responsibility in the media?

Anyway, this person from the research department told me what people like to read in "Science Times." They always remember any kind of medical story, without fail. And if surveyed on a particular issue, they will always name the medical story first. They love stories about animals almost as much as stories about medicine, which astounded me. I like stories about animals, and I'm always arguing with editors above me about the need to run more of these stories. People also like anything that has to do with plants, with the beauty of nature and of life.

If we measure what people like in terms of mail, reader comments by telephone, and comments by other people at The New York Times (which, unfortunately, I think reinforce us too often, and we project what our colleagues say onto the whole public at large), then they also like medical stories.

We did a story recently about Type A behavior, and we had a checklist of characteristics considered Type A that endanger people because of heart disease. I was astonished to see how many people on the subway were not only reading that story, but reading it to a neighbor. I had dinner with a friend, and the people at the next table were reading it to one another. That's the type of article people want.

What's not popular? We did a big story about the latest on ozone and spray can propellents and whether the stratospheric ozone layer is being depleted. I'm sure there was a big yawn, but it's an immensely important issue. We could be mortgaging the whole earth's future with this very issue, yet I'm quite confident to say if I were to ask the Times researchers, they would say that story was a failure.

We did a story about the technology of the SALT treaty verification. What is the technology that allows us to figure out what the Russians are doing? It was a very important story, in my opinion. But it drew a big yawn around the building and with readers.

The final question is: Should we as journalists give the public what it wants? The answer is, no. We can give the people some of what they want. Occasionally we do pander to the reader. But we also must give them what they need to be an informed electorate.

Another popular story was about a survey on sex for the elderly. I went for a walk that Tuesday at noon, and I sat down on the steps of the New York Public Library near two elderly gentlemen. And that story was the topic of conversation. They were just fascinated.

We need that kind of story. But we need to tell people about the controversy over a new president for the National Academy of Science. We need to tell people that the ozone problem is still with us. We need to tell them about SALT. So I think that some of Rae Goodell's criticisms of the media are all too true. We're much too concerned with controversy. I've been concerned that the new science magazines are going the "gee whiz" route. I thought we had left that behind several years ago, but apparently not.

We also have to recognize that people hear only what they want to hear. I have a good friend who's a brilliant journalist and a highly educated man, but he has smoked more than a pack of cigarettes a day all of his life. There was a paper in a journal about research showing that smoking tended to reduce the incidence of a certain kind of cancer. My friend dragged this out and made a big deal out of this report. That's going to serve as his justification to smoke for some time to come. We have to recognize that people hear what they want to hear.

I was happy to hear George Tressel say that we must distinguish public understanding of science from public appreciation of science. The idea of public understanding of science and NSF support of it has been around for close to a decade. I used to be very irritated by that concept and also quite irritated by the whiny tone some of its proponents took. It was a tone that said, "If we could only get the public to appreciate how wonderful we scientists are and what we're doing, then there'll be no problems with research money. Congress won't be cutting budgets; OMB won't be cutting budgets; Proxmire won't be giving his Golden Fleece award."

I think that's very narrowsighted. We've had in this country in the last 25 or 30 years a revolution in the way we finance science. A large proportion of all the research money in this country comes from the federal government. That's my money and your money. And it's high time that scientists and the public information people tied to the scientists recognize that science must be accountable to the public and that scientists must be available. Then it's the journalists' job to try to present science in a credible way. I'll be the first to admit that we have a long way to go. But the fact that we at least have editors and

publishers now willing to put their money behind big science magazines bodes well. I would also warn that we shouldn't become complacent.

THOMAS MOSS

It's hard to say, from the point of view of the Congress, how science and university research is perceived. I think most of the people in the political arena think of themselves as readers of public opinion as much as formulators of their own perceptions. To a great extent we base our actions on our view of the public's perception of university research.

There are several kinds of issues coloring public perceptions of university research, at least as they filter into the political arena. I'll start with the rather trivial, and yet important, end of the spectrum that I think is influencing political perceptions and then go to some more global themes.

The first one, which has probably caused you much more concern than you ever dreamed, is Circular A21, the OMB circular on reporting requirements of time and effort. I think there's enormous confusion as to whether this should be considered a major attempt to undermine the independence of the university system and the freedom of academic research, or whether it's a minor annoyance. Both kinds of signals come from the university community; both get into the political community, and they generate battle lines on one side or the other. That situation is then conveyed to the public in various forms.

In retrospect, I don't know how the surrounding confusion or controversy could have been avoided. The feelings about A21 and what it means for university research are coming in very unintegrated forms from individual universities, individual professional societies, and sometimes even individual departments within a university. From our point of view in the political arena, on the receiving end of these feelings, we're quite mystified as to what it all adds up to. The feelings range from fears that the fabric of independent research in universities will be destroyed, to annoyance over some minor paper requirements that are probably no different than those the state legislatures have made.

Moving up to more substantive things, the general budget stress we've faced in the last year or two is also coloring perceptions. Again, I think the political community is receiving input from the university community that is rather incoherent. I don't mean incoherent in the sense of not being well-formulated, but in the sense of not being well-coordinated.

In 1980, we for the first time really implemented the Congressional budget process--that is, we set a top level of funds for the entire budget and then, in category 250, the science category, we had a sublevel ceiling imposed. For the first time we were faced with some basic national choices in terms of priorities between high energy physics and the National Science Foundation and NASA. And we couldn't wiggle away from

them as we had in the past, when we just let the sums add up and called that a budget.

If this exercise continues in this fashion--if there really is a debate as to trade-offs between money going for space research as opposed to fusion within the Department of Energy or in university-based laboratories--, we will have to refine our decision-making system so that the various views of the parties are much clearer in advance of those discussions.

Going up another level of profundity in this kind of debate is the general discussion we've been having on the relationship of applied and basic research in the National Science Foundation and elsewhere. Right now the NSF, as many of you know, is reorganizing or planning to reorganize its applied science division. That affects a lot of university programs. There has been a big information-gathering system. And, again, I don't think the argument has really been conducted in the most rational fashion. Instead, I see our own committee and people with whom we're in contact jumping from rumor to rumor as to what's going to happen to a program in information sciences, in earthquake prediction, and so on. Affected or interested scientific groups may never know exactly what the proposals are but still may generate letters, never knowing whether some other advocacy letters are going to go out from other groups at the same time. All this narrowly based and self-protective activity can take place without ever framing the debate on the basic question: the relationship of applied and basic research in the National Science Foundation or in the university.

That comes to another theme that is emerging with greater and greater frequency: the question of industry-university relationships in research programs. More and more, Congress is looking for this kind of relationship, looking for ways to stimulate it. One reason is that Congress may be unwilling or unable to appropriate the kind of funds the university community feels it needs to have strong research programs. Second, Congress feels that it wants to rejuvenate American industry by putting it in contact with the best technical minds. Third, it wants to strengthen the relationship between basic and applied research. All those things add up to ideas for re-establishing university-industry relationships.

I come from Cleveland, Ohio. As did many students of science, I assumed I would go to Case Tech. As I learned about Case, I perceived, in a very favorable way, the relationship that a university like that had with the industrial system in a city like Cleveland in the '50s and perhaps early '60s.

Unfortunately, when science support moved to a more national basis, as it did in the '60s, much of that traditional relationship was broken. I don't think Cleveland and Case University were isolated examples; I think that occurred in many areas. Now we're trying to re-establish some of those relationships between universities and their local constituencies, and it obviously is going to affect the nature of university research. I think it can do so in a constructive fashion.

That brings me to another thought about what is going to influence the political community's perception of university research, and that is the development of research in recombinant DNA and its applications. Here is a model of the translation of fundamental basic research conducted in the university system into something of enormous societal relevance and interest. The technology transfer system is working very efficiently. The strong researchers who started in universities when this was a rather esoteric field of scientific endeavor are now the key people in the firms beginning to commercialize these developments. There are hardly any characteristics lacking to qualify this example as an ideal model of translating university research into something to meet a societal need.

The perception of this kind of development is going to influence the political community's view of what university scientific research ought to be and how it ought to develop in the future in other fields. Unfortunately, as we know, what happens in one field, for historic, accidental, or personality reasons, often doesn't translate into another field. We may have the familiar phenomenon of trying to do things exactly the way we did them in one field and finding out that it just doesn't work in another field. That will be a disappointment. But I think it will color what will happen.

From the political community's point of view, there's also going to be enormous interest in the scientific literacy of the public--not literacy for cultural reasons but literacy for two very profound political reasons. One is to enable the public to make the choices that the political community thinks will be necessary. How should citizens vote on a moratorium on nuclear reactors? How should they view the recommendations of a citizen's committee on recombinant DNA research? Those kinds of questions coming more often into the political arena really require a scientifically literate public. I think the political community sees its own interests in building that literacy, so that it does not have to become the translating medium between the scientific community and the public.

Second, with all the concern for the country's industrial position in innovation and productivity, I think there's more of a perception that the basic workforce has to be equipped to move into a highly technological world and that the university system is probably one of the key elements in building this technically professional workforce.

One last point to consider is the fundamental change in the demography of the university student body we're likely to be seeing. That is, there are not all that many 18-to-21-year-olds, and perhaps the university of the future shouldn't consider these its main concern. Maybe some of the main concerns will evolve out of these other themes--university-industrial cooperation, public literacy programs, and so on.

Whatever policies we have, they're not likely to change the fundamental demographic trends that are occurring. So I think we have to reflect a great deal more on what those mean and how the university will have to be changed to meet them. I read about these trends, I hear about them,

and I don't know what we ought to be doing about them, if anything, in the political system. I think whatever the political community does about these trends is likely to be less effective and less well-targeted than ideas that come out of the university system itself.

Question: Mr. Stockton, how does one actually get in communication with The New York Times about work that seems important?

Stockton: I think the most useful thing is a letter. My news assistant probably answers the telephone 150 times a day, and everyone who calls wants to speak to me. And at least one-third of them are more off-the-wall than the people who write the letters I read you. If a public information officer comes to New York and wants to see me, all you have to do is identify yourself, your university, your affiliation. I do return calls; we all return calls. In fact, we had an interesting affair last winter involving a Russian and his mathematics. Some of you may have read about it in the Columbia Journalism Review. The Review, incidentally, we thought was quite unfair in its presentation of the issue, and, of course, we've written a letter of rebuttal. This was a case in which The New York Times made a mistake, which, in fact, it frequently does. We're human, as everyone else is. We misinterpreted some work by this Russian, certain members of the mathematics community were quite upset, and they completely failed in their attempt to communicate to The New York Times that it got the story wrong. And not one of the upset mathematicians ever called the department and actually said, "I'm so-and-so at such-and-such university, there's a problem with this story, and we think it's very important that someone in authority be notified." The two letters we received over a period of two months failed to communicate that fact. This illustrated once again the difficulty the scientific community has in dealing with the press.

If you write me a letter, you'll get a response, and I'll be happy to see you. We're happy to listen to you because we're looking for ideas.

Tressel: Don Herbert, who produces a series for commercial television news programs, has told me that he has a difficult time getting source material. He said one of his problems is that there are only roughly half a dozen public information people in universities who really understand what he wants, the kind of format he wants it in, and how to send it to him--partially digested with a discussion of visual materials to support it, and so on. His problem is that these half dozen people are so successful and so skilled at providing material it's getting embarrassing to have every other report from these same few universities. One of the needs is for people at universities to understand what kind of material and what kind of format are needed. I wonder if you have the same kind of problem at The New York Times.

Stockton: I certainly do. In fact, I could give a seminar on how to write a news release that will get any editor's attention. I read dozens of news releases everyday, and my rule of thumb is that if a release can't sustain my interest through the first two paragraphs and at least tell me what's going on, I won't spend much more time with it.

I find one of the most helpful things--and Purdue is an example--is a summary of things going on, a list of story ideas. And if you write a news release, tell us in the lead what it's about. We got a news release recently from a prestigious medical center that was giving a very large award to scientists with money from a patron of the university. One of my editors went through and lined out all of the garbage, the extraneous information. I recognize you have politics you have to deal with. But this was a six-page release, and the last four pages were all about how wonderful the woman was who gave this money. The first two pages conveyed the news in less than 100 words. The rest was garbage. We wade through that everyday--news releases with leads that don't tell the story. And sometimes the lead is overstated. The same old rule applies: clarity and brevity.

Question: Dr. Moss, the phenomena of university-industry relationships in collaborative research is probably the wave of the future. I'm also told that one of the major stumbling blocks to this kind of relationship in this country is the anti-trust law that forbids local universities and companies such as GE, Westinghouse, and Texas Instruments from all collaborating on a single research project. Do I understand that correctly, and does Congress intend to do anything about that problem?

Moss: I think you understand the problem. I've heard that problem many times and the Congress hears it many times. I think it reflects less what is in the law than it does patterns of thought that have been institutionalized when we had different priorities. There was a period when we thought we could maximize innovation and competitiveness by having the maximum independence of domestic firms, promoting the maximum competition, and making sure there was no collusion or conspiracy. So we institutionalized those concepts. People in the Justice Department organized their bureaus that way, and they've always behaved accordingly. Now I think it is a matter of policy to be much more sympathetic to partnership arrangements, even within domestic industry, for the priority of world competitiveness. Still, the institutional mind set exists--and on both sides. That is, the general counsel of the corporation says, "If we sit down with these people, we're really going to be in trouble; I remember in 1964 when we did this, we were in trouble." Now, the people who were in the Justice Department in 1964 may be gone, or they may have different instructions and may act differently. But the company's general counsel still thinks they'll act the same way. Similarly, the person in the Justice Department may have the same reaction, keyed to past policies and priorities. So I think the institutions are changing, but there's a lag between the change in national priorities and change in bureaucratic response. Congress and the executive branch already have taken some steps to enforce new priorities, but it can't change institutions magically, either.

Question: One thing disturbs me about the reporting of advances such as DNA technology. There's not a good feeling in the popular press for the enormous amount of basic research that goes into those advances. Those particular pieces of basic research seemed esoteric at the time, and all of a sudden they've become applicable. Dr. Moss, do you believe legis-

lators understand how much of that research was done with no aim as far as practical application, and how difficult it is to decide, at the time the research is being funded, what the practical applications will be?

Moss: I think there is an understanding. Another example often cited is research in solid state physics on the transistor. We have often said, "Look, we did all this basic research and made a transistor, and it's transformed the whole world." That argument has been used in various forms for 20 years to explain the significance of basic research, and I think it has been effective and has made its point. I assume that the life sciences will exist happily on the example of genetic engineering for another couple of decades. I think there is also public understanding of these events, and it will be very useful for the sciences in the next two decades.

Stockton: I've had a strong feeling for a number of years that we are not putting enough effort into basic research. I personally feel that the war on cancer, which is an unfortunate misnomer, has placed too much emphasis on targeted research. We're seeing more of this because people want results. We want to solve the problems at hand. You can look at the DNA advances and cite any number of examples of research in the last 15 years that came strictly from pure, basic research. It's interesting that the British scientist who has won two Nobel Prizes in chemistry writes about one paper every 10 years. He's not caught up in this "publish or perish" syndrome. He's been at the same institution since 1951, and he has not had to worry about writing proposals and getting the lead right. He has not had to worry about some young person taking away his endowed chair because he hasn't published enough pieces in the journals, and so on. I think that's a serious problem that research faces. But I also agree with Dr. Moss that we can glide along on the DNA example for many years.

Question: Before that kind of philosophy is generally subscribed to, and before the public is willing to go along with such generalized support, it has to be able to understand the issues. You decried current magazine attention to "gee whiz" stories. It seems to me from the work that Dr. Goodell was describing, one can imagine a hierarchy of interest, consisting of people who just don't care and won't pay any attention to you at all, people who will pay attention if it's "gee whiz" reporting, people who pay attention regardless of what it is, and people who are seriously involved in issues. It seems to me that if we want people to pay attention to issues, you have to work at that whole spectrum at the same time. What one would like to do is move people from one of these categories up a little bit higher so that they have more insight and more sophistication. Doesn't that imply that we have to have some "gee whiz" material mixed in with this?

Stockton: There's a magic word at The New York Times in the science department, and it's "mix." I hear it several times a week. Every Tuesday when we start talking about what's in next week's section, "mix" is tossed around quite a bit. I agree that to a certain extent we have to educate people, and that's a philosophy that I feel strongly about. Frequently we'll have a proposal for a story that is an education

approach, and the question will come from one of my colleagues, "Where's the news in this?". We are a newspaper. Sometimes if we look hard enough we can find the news in a piece that's still basically educational. Sometimes, if we're adroit writers, we can do what in the trade we call a "hip fake" and have an interesting piece that's not too filled with news, but nevertheless sustains the reader's attention and educates him or her at the same time. Then we also need some of the "gee whiz" stuff, although I don't think any science, even the most interesting, has to be presented in that way. I think it should be written in a responsible way that gives perspective on its background and its future implications without having to say, "Wow, isn't this wonderful and marvelous!". It's also necessary to have stories that address difficult, but possibly boring, issues. Everyone in the media has to strive for this mix. When I look through Science Digest, Discovery, and some of the other science magazines, I can see what they're trying to do. They're trying to be lively and bright, and all of them are doing a good job. I hope that we'll see more turning to major issues and perhaps sober examinations of serious issues. I think Science 81 has certainly been doing that. I don't think Discovery has been here long enough for us to tell. I don't think I see that yet in Science Digest, and not a great deal of it in Omni. So, overall, I'd say we need more of that type of coverage.

Goodell: I agree that, even if half of the U.S. population comes across as totally turned off to science, the media must address the needs of that half, as well as the half that is paying some attention to science, with a mix, as Bill Stockton says. I'm, therefore, concerned about what I see as the trend toward specialization in science news, the trend toward putting it in special sections of newspapers and special magazines. It seems to me that that practice is saying science is special, science is different. It's like sports; it's a special thing that you may or may not be tuned in to. It discourages the notion that science is just another part of the news, just another part of social life. I think it may, if anything, aggravate the problem of people being either turned on or turned off by science.

Another way of seeing it is not only in the advent of certain things like special science magazines and science shows, but also in what may be a decline, or at least a lack of growth, in science coverage in the regular course of news in newspapers.

One thing editors do that makes some sense is to ask a science writer coming up with a story, "Is this really going to appeal to a broad spectrum of readers?". I think the influence of editors responsible for a broad spectrum of news, not just in science, is important--they're at least trying to reach people who are turned off. If we get too specialized with science shows, science magazines, and science sections, I'm afraid we're going to make the problem of the turned-off reader even worse.

Question: Mr. Stockton, how many writers do you have on your staff?

Stockton: The New York Times prides itself on having covered science with a large team for many years. So to start the science section, no new reporters were added. There are now 10 reporters--nine in New York and one in Washington. When the section began, the Times added editors, an art director, and a graphics editor. So, counting myself, there are four editors, plus a graphics editor, an art director and his assistant, and 10 reporters.

Question: Mr. Stockton, I'd like to know how much you depend on people like us to get ideas. If you have 10 reporters, do you generate most of your own stories?

Stockton: I'm constantly looking for new, unique ideas. That's why I try to read so many news releases. I'd say my staff generates a third to a half of the things you see; my reporters, my editors, and I generate the rest. I'm always looking for any story that no one else has had, that's different, that's catchy, that's important. And I'm always surprised at how little I get from public information officers. An example is our coverage of research on stagefright. I ran across that idea while browsing in the medical library at the University of California in San Francisco. The research was reported in the Rocky Mountain Medical Journal, a regional medical journal. That was a wonderful story for New York City. When we started investigating this paper, we discovered there were a number of people working in the field, and there were some people in New York City dealing with stagefright in this way. It was an interesting story and got a lot of attention. I'm not sure to what extent it was socially useful but, you know, not all of our stories are. It was something that at least enhanced people's understanding of science and what it can do.

Question: Are you saying more or less that if you receive a press release, it's obviously going to people in addition to you, so a letter might be the best way to approach you, with a statement that you are the only person receiving the information?

Stockton: Yes, I prefer what I call a one-page query letter saying, "We're offering this to you first, and if you're not interested, please let us know." Then we'll tell you whether we're interested. That's the easiest way. And maybe, if it's available, you might include background information of some kind to flesh out your letter.

Question: Dr. Tressel, what is your reaction to the suggestion made earlier that we as public information officers should have backgrounders or briefings for news media people who are not science writers, for people on papers that have exhibited no interest in covering science? What do you think about that idea, and have you supported programs like that on a local level?

Tressel: We at NSF do have considerable interest in that. Last year we funded a Lehigh University project that held seminars for journalists in the area. It would have been nice if we had done it a year earlier, before the Three Mile Island incident. But it's a noble effort on

Lehigh's part. Unfortunately the amount of money that's available to do that is limited, and if one extrapolates that to every community in the country, we wouldn't have enough money to even begin to touch the problem.

It is a shame that people graduate from journalism school knowing practically no science, when we know that most science will continue to be reported by people who don't carry a label as a science writer. If someone came to us with a proposal to develop a curriculum, not for science writers per se, but for the nonscience journalist, there's very little question we'd be interested. And if it were a good proposal, I would be surprised if it weren't funded.

In the meantime we did support Lehigh, and we welcome more proposals like that, though we're not sure that everybody knows how to do it. We've had some disastrous experiences trying to support such seminars by people who were less than sophisticated. At one seminar, only two reporters showed up, but the whole university community attended. That really isn't what we're all about. So seminars for reporters are easier said than done.

Question: Mr. Stockton, what is the science educational background of your reporters? Do you require a science background?

Stockton: No, we don't require it. We require an inquisitive mind and an ability to write scintillating copy or to write clear copy. We have a medical doctor on the staff. I'm a chemist. There's another chemist, a biologist, someone with a master's degree in psychology, someone with a degree in agronomy, and the rest majored in other areas. I'm a great believer that you don't have to be a scientist to be a science reporter; you don't necessarily have to have a degree in the sciences. I think you do need an ability not to be awed by an arrogant scientist, or not to be afraid of technical material. Most of all, you need an inquiring mind.

Question: Dr. Goodell, I think there may be a converse to the scientist at the tip of your pyramid, and that's the one who gets almost too much publicity. Do you have any ideas on how much responsibility public information people have to direct reporters to other people doing interesting work, and how much responsibility rests with the journalist who tends to go after people who already have established names?

Goodell: I think it's everyone's responsibility to be aware of the problem. In a way, I'm more concerned about the ones who welcome the attention and who are willing to be regular sources and to comment frequently. Their point of view is indirectly included much more often than it should be because it's not considered a point of view, it's viewed as "the truth." I'm particularly concerned, not just about controversial areas where scientist X says something and then scientist Y is quoted as saying the opposite, but about the same people telling the Times, the Post, and other papers over and over again what is and what is not good astronomy. Then we're getting a very limited range of stories.

RESEARCH MAGAZINE--A NUTS AND BOLTS ACCOUNT

William R. Kell
Editor, Research
University of Minnesota

Right from the start, a small claque of magazines took their places to view the explosion of knowledge over the past century. Fairly technical publications such as The Scientific American and general circulation magazines such as The New Yorker have long worked to explain science and scholarship in lay language. A few university-related journals--MIT's Technology Review is the best known example--entered the field as higher education began playing a bigger role in American life.

In the past several years, as if guided by common purpose, both commercial publishers and research universities have sensed a greater public appetite for information about the state of the knowledge arts. Now the rush is on. Like latecomers, long after the curtain has risen, new commercial science magazines and university research publications are sidling noisily to their seats.

On the one side we have witnessed the arrival of Science 81 from the American Association for the Advancement of Science; Discover from Time, Inc.; Omni from the folks who brought you Penthouse; and a refurbished Science Digest from the Hearst Corporation.

Similarly, universities have developed new magazines to report to the public on research. Well-established journals such as The Research News (University of Michigan) and UIR/Research Reporter (University of Wisconsin) have been joined by over a dozen new research periodicals in the past decade. A survey, doubtless incomplete, includes American Inquiry, The American University; Chronicle, University of Maryland; Research at the University of Arkansas; Discovery, University of Texas, Austin; Enquiry, University of Delaware; Focus on Research, University of Illinois, Chicago Circle; Lehigh University Research Review, Lehigh University; Matrix, Rutgers, The State University; Perspectives, Southern Illinois University, Carbondale; Research, University of Minnesota; Research & Creative Activity, Indiana University; Research Directions, Drexel University; Research in Action, Virginia Commonwealth University; Research News, University of Wisconsin, Milwaukee; Research/Penn State, Pennsylvania State University; and Research Reporter, University of Georgia.

Without some investigation, it is difficult to understand why these institutions--and those who have research periodicals on the drawing board--suddenly have committed scarce resources to this task. Perhaps our experience at the University of Minnesota in the creation of Research magazine can shed some light on the matter. What were our objectives, and how would they be pursued? What audience did we want to reach? And how, both with regard to purpose and effect, could we compete for reader attention with commercial publications having enormous resources at their disposal?

Like other research universities, the University of Minnesota has become strongly committed in recent years to communicating with the public about the scholarly activities and accomplishments of its faculty. In some quarters, at least, we have come to believe that the very heart of the institution--its intellectual life--has not been thoroughly represented to our constituencies and supporters. That conclusion seems even more compelling because we have become a society that depends on knowledge more than on anything else. As Business Week put it recently, "Information handling is already America's biggest employer." Our way of life now demands that we understand what makes our world work; what fuels the economy, or causes it to run out of gas; how opportunity is created out of the raw materials of possibility; how ideas are born, how they grow, change, and fade.

Such appetites are natural in a democracy. Fearing a tyranny of experts, we believe the electorate must be well informed. Efficient government, we know, depends on public reckoning of expenditures--including those for education.

Beyond changing tastes and established public values, there is also a personal rationale for publications such as Research. In this era of strict specialization, many of us wonder about the logic and processes of thought beyond our own vocational training. We want to share, as we can, in the continuing endeavor of our finest minds to grasp reality, to become a bit more at home in our universe.

In this very broad educational process, research universities play a central role. They initiate most of the ideas from which products, processes, and services eventually develop. More than that, they train in their graduate programs the new professionals who help make these things happen.

Public and land-grant universities, especially, bear responsibilities to convey the knowledge they develop to those who want it and need it. In addition to classroom teaching, these institutions have traditionally met this obligation with specific client groups in mind. The information systems that have blossomed for agricultural extension activities are always cited as one example of the job well done. But in many other areas, the principal intellectual output of universities has been professional publications. The general public, especially certain segments who want to stay abreast of developments in a variety of fields, is only now coming to be regarded as a normal constituency for information.

In the United States of 1981, public interest in research should come as no surprise. Our social system relies foremost and forever on knowledge. Even if we wanted to return to an industrial or agrarian economy, built on hard physical labor, our bridges have been burned. Our social organization is too complex, our labor too expensive, our people too educated. In the words of humanist Douglass Cater, "approximately half of the American payroll now goes for the manipulation of symbols rather than the production of things." In the international arena, our one continuing calling card--which makes friends for us and keeps other

countries respectful of our power--is what we know, not what we grow or manufacture.

Research magazine found its genesis, then, in this mix of needs, issues, and attitudes. Research was born of the conviction that we could locate--within the covers of a quarterly periodical--glimpses of some of the most significant new knowledge in process.

One of my colleagues calls our project "outrageously ambitious." After all, up here on the plains of the Great American Basin, how can we keep in touch with the intellectual nerve centers of the nation? While our home institution is regarded with respect, it doesn't appear on everyone's short list of premier universities. The University of Minnesota is, nonetheless, a valuable national resource, resting on the remarkable popular commitment of a state listed 19th nationally in population and level of income. Even compared to the smaller private universities with impressive financial bases, the University of Minnesota--with its extensive resources and diversity--is a gold mine of opportunity for the journalist.

Our new magazine capped off an extended period of planning and experimentation. Three years before publication of the preview issue, the academic leadership at Minnesota had concluded that the problem of research communication was serious enough to warrant a separate publications effort analogous to the specialized shops for sports and agriculture. On the assumption that the appropriate audience would not be the general public--the presumed target of most information programs--, the academic leaders decided to locate the new effort in our office, the Graduate School Research Development Center, whose charge it is to encourage faculty efforts to secure sponsored research support.

Over those three years of preparation, we produced several shorter publications about research at the University of Minnesota. A few were related to specific requests for research funding before the state legislature and were used in other settings as well; some were specific reports. The first one, unlike the rest, was a general argument about the importance of university research.

As time went by, we learned that audiences are more sophisticated than journalists often think they are. Although what we were saying in many of those earlier publications was true and useful, it was always presented in the context of the University of Minnesota: which professors were doing what, and how much better off everyone was as a result. The emphasis was on the internal workings of the institution, rather than on the more important and appealing subject, research itself. People are truly interested in the process, results, and applications of research. They are not so very interested in the University of Minnesota as such.

We have come to believe, therefore, that the intellectual life of the University of Minnesota needs to be placed in a national, even a global, context. We must show how research innovations conform to established ideas and contribute to new knowledge in a post-industrial society as a

whole. Research needs to be presented, in other words, as if the university understands its place in the scheme of things. This proves to be the fundamental difference between research communication and conventional university public relations.

University and college public relations has been modelled very closely on corporate practice and has been most often managed by public relations generalists and newspaper-oriented journalists. Probably the main exception has been client-group work in medicine, agriculture, and engineering. But the usual goal has been to achieve the broadest possible exposure to the audience of greatest possible size. If you aim at a mass audience, however, it is unmanageably difficult to present a message based principally on ideas: many people, in fact, have pronounced the attempt hopeless.

Yet, we are struck with the observation that the essential feature of a university is the one most fully concealed from the outside world. Lots of people have some notion of how the football team is doing, whether the state government is supporting building and budget requests, which faculty and students are making scandal news, which famous alumni are visiting the campus, and so on. The public is also aware of some applications of medical and agricultural research. But how much do most people in a natural constituency know about scholarship and scientific investigation on the campus?

That observation brought us to Research magazine. We came to the conclusion that our occasional brochures and reports did not go far enough in keeping the research message before our audience. We needed something more regular that would be recognized for what it was. Fortunately for us, other publications had broken some ground. The one which intrigued us most came from the State University of New York. Search, developed and edited by George Keller until he moved to the University of Maryland, had achieved something special. It behaved more like a general circulation magazine and never presumed that the reader cared much about where it originated. That, we thought, gave it an edge of credibility.

From almost the very beginning we assumed several things. First, our magazine would need credibility beyond the stamp of the institution. Articles would be developed and presented as if for general circulation: professional standards of selection and execution would apply, and academic politics would be avoided. Second, it would need a format that could compete effectively in an age of heightened visual opportunity and literacy; the look of the grey scholarly journal, however dignified and tasteful, simply made no sense. Third, it would need the best kind of writing, making it possible for the educated person to read about intellectually substantive matter without an encyclopedia or special training in the field under discussion. Fourth--and this was the most unusual assumption we made--, the audience would consist of people with some college education, presumably interested in new ideas, and with responsibilities or activities that in some way connected them to research at the University of Minnesota.

Our circulation list--and the ways that list shaped our notions of our audience--had evolved through the production of those publications mentioned earlier. Because of their variety, and because we were always thinking of new potential audiences, we had a good start on at least an initial circulation structure for Research magazine. I'll describe the way our audience listing is broken down and try to make a case for each category we finally included. In doing that, I hope I can show what we expect from Research over the next several years.

While our primary audience is meant to be opinion leaders, we see opportunity also in reaching those who themselves communicate with the general public. We observed this opportunity when newspapers in the state began writing editorials about our work, including one of the most boring subjects for a newspaper, the importance of research in modern society. We also discovered that newspapers in small towns would reprint parts of our brochures, often without a bit of rewrite. Also, by interviewing editors at newspapers and magazines elsewhere in the United States, we learned that they are as open as anyone to suggestion by something presented in an attractive format.

So, one category of our mailing list is called MEDIA. It includes editors and publishers of all newspapers in Minnesota and bordering communities; they number over 500. In addition, we have selected wire editors, staff editors, science and education writers, and columnists at those same papers, particularly the larger dailies. We also have selected several hundred science and education writers, and editorial page editors, at daily newspapers with regional or nationwide circulation.

To improve our national exposure, we have selected writers and editors of general circulation magazines in these categories: business, education, general editorial, humanities, science and research, and youth. We also have included Minnesota magazines in other categories, serving our state primarily, and inflight magazines of airlines serving Minnesota. For radio and television we have listings of program directors, station managers, news directors, and, again, selected staff--both for Minnesota stations and national networks.

We have two other devices by which Research reaches out to the general audience. The magazine is placed in over 1,000 libraries in the state--public, higher education, and secondary education. It is also available in the libraries of major research universities in the United States and in smaller institutions that are land-grant or sea-grant colleges.

Finally, we place Research in selected public locations in Minnesota, including the waiting rooms of health maintenance organizations, group medical clinics, senior citizen residences, nursing homes, hospitals, and similar areas where a copy may be seen by a fair number of people over the course of three months.

In these ways, we hope to meet our obligation, as a magazine in a public land-grant university, to make information about the scope and value of research accessible to the broader public.

Most of the remainder of our non-university mailing list, then, consists of people we regard as opinion leaders. Our very first publications three years ago were directed primarily to Minnesota political leaders and people in public agencies administering research grants. At the federal government level, we send Research to members of the House of Representatives who serve on committees responsible for research appropriations and to all members of the Senate: very few Senators, it turns out, do not serve on committees of this sort. In the executive branch, we have included officers of boards, agencies, cabinet departments, and quasi-governmental organizations involved with sponsored research. We also want to reach people in the federal government specifically charged with policy and planning matters related to the nation's research capabilities; these include the Office of Technology Assessment and the Office of the President's Science Adviser. Shamelessly, I should add, we have included the President, Vice President, and members of the Supreme Court.

In state government, our audience includes the legislature, constitutional officers, selected administrative officers, and public officials of cities and counties where the University of Minnesota has teaching or research installations. In addition to addressing public officials whose responsibilities involve legislation and policy, we also want to reach program officers at agencies where the research grants are administered, both at the state and federal levels. Similarly, we have included officers of private foundations that have in the past several years sponsored research at the university--and even a few who haven't but might be convinced to do so.

We also think it is important to reach those long-term contributors to the university who have supported its programs in a variety of ways, in part to thank them with a publication which, we hope, reinforces their interest and pride in the institution. These include several groups within our development organization, the University of Minnesota Foundation, our Minnesota Medical Foundation, our Alumni Association, and several smaller organizations attached to colleges or programs.

Because the University of Minnesota is a very large institution in a relatively small state, it touches the lives of people in a broad spectrum of vocations and activities. And, although not all of these people might have direct interest in particular research projects and activities, their awareness of general intellectual directions at the university could be helpful indirectly. For convenience of classification as much as anything else, we have broken these into four general groups: BUSINESS AND LABOR ORGANIZATIONS, PROFESSIONAL ORGANIZATIONS, CULTURAL ORGANIZATIONS, and CIVIC ORGANIZATIONS. Parenthetically, I should say that in each case we address the magazine to a particular person, not an office or organization. This procedure was forced by the system our data processing people use to keep mailing lists, but we became convinced that our opinion-leader orientation might be better served if we knew who in a given group or organization might be reading Research. In most instances, we use the names of the central governing board or the chief officer.

Under BUSINESS AND LABOR ORGANIZATIONS, we begin with officers of labor groups in Minnesota--over a thousand, as it turns out. While the number seems outrageous, and the connection with research seems relatively remote, we have felt reluctant to make finer judgments until we have studied the impact of the magazine. If it turns out that business or labor people hate it and throw it away, we'll remove most of them from the list. This is true in other areas as well: even though two members of the U. S. Supreme Court are Minnesotans interested in the work of the university, other justices may find this publication peculiar in their morning mail. Since Minnesota is an important farm state, our next category is presidents of agricultural and producer organizations. As you know, they already are well served in their own disciplines by the work of agricultural journalists, but we think that some understanding of the rest of the university would be appropriate as well. Then, we have selected nearly a thousand companies in Minnesota whose work somehow depends on research and knowledge; the chief executive officer of each receives the magazine. So do the heads of nearly 300 business-related professional and promotional organizations; some of them have been very interested in our smaller publications and have requested multiple copies. Business advancement groups want to deliver, to firms thinking of locating in our state, the message that they will have available to them an idea and manpower resource that reaches out to the public.

Our next category is PROFESSIONAL ORGANIZATIONS. More than any other group their working activity relies on the developing knowledge base. Most of them, as you know, have ongoing relationships with parts of research universities, but very often the interdisciplinary or collaborative potential of a university is not clear to them. Among the fields included are the arts, commerce, education, engineering, science, law, medicine, and public affairs.

Partly because the University of Minnesota has helped develop and encourage cultural organizations in the state--the Minnesota Orchestra and Tyrone Guthrie Theatre are two with which you may be familiar--, and because their boards of directors often include some of our most influential citizens, we have included the heads of Minnesota arts organizations generally and the boards of the more prominent ones in the Minneapolis-St. Paul metropolitan area. They comprise our CULTURAL ORGANIZATIONS category.

Like the three previous groups, the CIVIC ORGANIZATIONS category pinpoints those people who are most active in the community, not just through politics. Included here are church and church-related groups, conservation and environmental organizations, fraternal associations, health-related groups, nationality or ethnic groups, and veterans and patriotic organizations.

Finally, we wanted to address the education community--both local and national. The fortunes of a research university in some ways depend on the opinions of other higher education professionals. We want to reach the governing boards of the Minnesota state universities and community colleges, as well as the advisory group that makes recommendations about

the future of higher education to the state legislature. We have included the leadership of other colleges in the state and of the Committee on Institutional Cooperation, a regional organization. We also are interested in the presidents of other research universities and the leadership of national education and research organizations--many of them based in Washington, DC.

We wish every one of our students could have a copy, but production costs make that impossible. Research will, however, be available in all University of Minnesota libraries, in lounges of dormitories, and the like. We also have selected a few groups of students to be on the mailing list. They include graduate students who have received fellowships from the university or elsewhere, undergraduates designated as Presidential Scholars because of their academic achievements in high school, and student government officers on all campuses.

We also provide the magazine to members of the faculty and selected administrative staff. Beyond the aim of keeping them informed of what Research is up to, we have another less obvious but more important purpose in mind. The University of Minnesota is so large that some scholars working on very similar problems or in identical subject areas are not even casually acquainted with one another. We are continually struck by the paucity of collaborative and interdisciplinary scholarship and by the lack of appropriate communities of interest. Not only might improved internal communication affect the research enterprise, but it could have an even more profound effect on the quality of new courses developed at all levels. Moreover, there is a trend in sponsored research toward interdisciplinary and problem-solving projects. Although there are reasons for resisting some forms this interdisciplinary research takes, the fact remains that part of the research enterprise will continue to be devoted to work that brings together scholars from a number of fields to address a problem of public importance.

An attractive research publication can also help boost faculty morale, especially when budget battles tend to depress spirits. In the magazine's pages scholars can find evidence that progress continues, perhaps one small way of offering encouragement to everyone's work. Finally, at large multi-campus universities, publishing a single magazine with articles on research carried out in different locations gives reassurance that the farflung professoriate is indeed working toward common goals.

There are plenty of data available to show that the marketplace situation for academics has reduced the frequency of movement from one university to another and created a somewhat more inward-looking perspective compared with, say, 10 years ago. More faculty are interested in the needs of the communities they serve and oriented a bit less strictly toward the demands of their disciplines and professional associations nationally. Regional consortia, defended mainly on grounds of efficiency, continue to develop, and programs for sharing resources locally are becoming more prevalent. In this climate, we think, it is doubly important that faculty understand the interests and activities of their colleagues on the same campus or in the same university system.

Recalling Harold Ross's one-page birth certificate for The New Yorker, and the absence of any statement of purpose whatever for most periodicals, our planning for Research seems excessive to the point of embarrassment.

One might make the same observation about our editorial process, especially with respect to selection. Our position is that to be credible, for the purposes of the magazine to be served, we need to avoid acting like an institutional publication. Not only must our standards of editing and presentation be high, but our criteria for selection of materials must be sound. Although we are still working to refine those criteria and the process that flows from them, a description of what we have done thus far may be useful.

To select carefully, we try to keep abreast of what's going on across the range of departments at the University of Minnesota. To help us, we have requested the assistance of a large editorial board of roughly 50 faculty members whom we periodically tap for suggestions in their areas of familiarity. We also consult the regular documentation of the university's research enterprise, for example the dockets of the Regents of the university, which include the titles of all research proposals seeking financial support; the computerized listings of all grants and contracts received; and, in the minutes of the Regents' meetings, the posting of sabbaticals that schedule research work.

Sometimes, prompted by the magazine itself, faculty members volunteer information about their own research or the work of their colleagues. But we strive to complement that random news with a systematic solicitation of all units of the university for subscriptions to all their regular newsletters and other publications. We share a subscription to a computer service, offered by the Institute for Scientific Information in Philadelphia, which periodically provides lists of all journal articles whose authors are identified with the University of Minnesota. The service is called the Automatic Subject Citation Alert. To help us establish the context within which Minnesota research takes place, we also read general journals such as Science, Nature, and The American Scholar. These make us aware of broad trends in current thinking and place Minnesota's contributions in perspective.

When one of these devices yields an idea for a feature article or department item, we initiate a review. It begins with collection of materials from the scholar and some preliminary library checks to determine both where the work stands in its field and what the peer reputation of the scholar might be. If we are satisfied on these accounts, we check with several colleagues in the same field--two at the University of Minnesota and two nationally recognized authorities from other universities. We are interested in both their judgment about the work itself and the possibility of our doing justice to the topic as we have defined it. Finally, we attempt to determine whether we can come to the subject from an appropriate public angle.

Much research and science writing limits itself to translation from the language of the discipline to general terminology. It frequently does

not place the work in intellectual or cultural context and thereby fails, from the perspective of the general reader. Beyond an interest in ideas, why should the reader know or care about this area of research? What does the work have to do with anything else--including what has gone before it and what most of us learned as some form of gospel in school? In the process of asking such questions, we seek to discover an avenue of approach that links the unschooled reader with the scholar/specialist.

Our next step--surprisingly late, some have observed--is to have an extensive conversation with the scholar. We discuss the kind of piece we have in mind, including that crucial avenue of approach. If the scholar is indifferent or unwilling to give us some time in the editorial process, we will not pursue the matter further. If the discussion goes well, we conclude with an appraisal of who should write the article. Our choices include the scholar, a free-lance writer, or one of the three staff editors. (Thus far, a majority of our articles are written by free-lancers.)

We ask our writers to spend a good deal of time developing background, largely from readings recommended by us (out of that preliminary review process) and by the scholar. The writer conducts several interviews with the scholar at this point, and in some instances has brief conversations with the editors, if the project is causing problems or taking a new turn. First-draft manuscripts, seldom ready under such circumstances in less than two months, are then reviewed by an editor who has been in charge of the particular piece from the very beginning. The manuscripts are also checked by an editor who knows little of the project--in this instance more to represent the general reader than to polish the manuscript.

The second draft is checked and edited as quickly as possible. If everything has worked perfectly, the writer's task is complete; if not, there may be need for consultation at later stages. In any event, copies of the manuscript are now sent to the scholar and to an independent reader in the same field at another university; the latter is often someone with whom we have spoken in the preliminary review process and whose comments will be kept in confidence. Their reactions--which we ask to be addressed primarily to substance and accuracy--are then incorporated into the text by the editor. A copy of the final manuscript is sent to the scholar on the outside chance that we have made an unwitting error. Our final copy-reading and subsequent proofreading are all textbook procedure.

Finally, we should say a word about pacing. We have attempted to introduce some devices, common in commercial publications, to enhance the focus of the magazine and to give the reader some relief. Our practice of using single-panel cartoons and poetry related to the overall thrust of the publication has been criticized in some quarters--most often because these innovations diverge from what institutional publications are expected to include. We continue to believe that these materials are worthwhile, however, precisely because they are all original and approach readers from a somewhat different stance.

Whether the cartoons and poetry have helped save us from generic anonymity is debatable. Perhaps the most pressing problem of university research

magazines right now is that the genre has not yet taken shape. Among the magazines established thus far, there are wide variations in general purpose, audience level, frequency of publication, length of treatment, reliance on illustrations, selection of material, and authorship. What they have in common, however, seems a sufficient condition for that genre to emerge one of these days. They are all intended to let the public come closer to the intellectual excitement characteristic of the best days on our campuses.

Actually, they have one more thing in common: they cost money. In a period when higher education is straining to maintain itself, they are yet another financial burden. How can universities afford one more public relations program when faculty salaries lag behind not just inflation, but the average salary increments of the rest of the work force? How can money needed for classroom teaching, service programs, plant maintenance, and a thousand other worthwhile claims be diverted to a publication that, viewed from the stance of the most cynical citizen or media analyst, is a waste because nobody reads these days anyway?

While the answer to those questions depends largely on the circumstances of the individual institution, there is a universal if not novel response that administrators and editors dedicated to research communication know by heart: if it is true that we cannot afford this magazine, it is doubly true that we cannot fail to produce it.

REACHING CLIENT PUBLICS

Delbert P. Dahl
Head, Office of Agricultural Communications
University of Illinois at Urbana-Champaign

A handsome farm boy was walking home one day. He had a live rabbit in a basket in one hand and a pitch fork in the other and he was leading his horse as he walked down the road. A very attractive young farm girl joined him on his journey down the road and they came to a place where the trees were overgrown and it was quite dark. She said, "I'm a little concerned about being here with you because I'm afraid you might try to steal a kiss." The boy looked at one arm with the rabbit in the basket and the arm with the pitch fork and the rope leading his horse and said, "How could I?" She said, "I think it would be fairly easy if you put the rabbit down on the ground, turned the basket upside down, stuck the pitch fork in the ground, and tied the horse to it."

That farm girl had her act together. She saw a way to work it out. As I see it, that's part of the challenge of almost any communication task. I see working things out as the challenge of communicating university research. That was the challenge a group of us at the University of Illinois had as we worked on two efforts focusing on communicating research from our university.

It's by far not the purest kind of research reporting that we do at the University of Illinois or that I think other universities do, but it's something we're increasingly involved in--communicating research to the real clientele audience, but not forgetting that funding is part of the picture today. I think most of us in land-grant colleges are aware of that need for a variety of reasons. One of them is inflation, and so dollars don't go as far. Another is what's happening to the old three-legged milk stool that was for many years used to describe that partnership of local, state, and federal funding. Our federal partner is sawing off its leg of the stool, and I think that's leading many institutions into looking at the relevance of their programs and reporting that relevance to their audiences. That was definitely what we did in what I call two campaigns. I'll describe these two efforts and then discuss some related points.

One of the two efforts became known as the "Food for Century Three" program; its forerunner was a campaign we called the "First Hundred Years of Forever." I see "Food for Century Three" as a project that had absolutely no beginning. Nearly a hundred years ago our College of Agriculture on a fairly informal and limited basis began research and demonstration programs in agricultural and home economics. I'm certain the benefits of those early programs and others throughout the hundred-year period have been important to the success of our "Food for Century Three" campaign. Artificial breeding, the designation of the essential amino acids, the development of the corn combine--these are only a few of the innovations that we can trace without question to the University of

Illinois campus. We claim a lot of others, but so do other people, and we can't claim them without question. Each innovation and many others have been appreciated by Illinois people whose lives consequently have been made easier, or whose work load has been lightened. So in a sense the beginning was nearly a century ago.

However, for practical purposes, the beginning may have been the centennial celebration of the first agricultural experiment station. On that occasion, the College of Agriculture launched an extensive mass media campaign beginning in July of 1975, and we called that campaign the "First Hundred Years of Forever." Its purpose, pure and simple, was to get recognition for the agricultural experiment station, which is the unit within the College of Agriculture that carries out the research function, by telling our many clientele audiences and to some extent the general public about the benefits of agricultural research. We didn't know it at the time, but in retrospect, we can see that that campaign laid the groundwork for the "Food for Century Three" campaign. It was a beginning, but we didn't know it at the time.

The plan for the "First Hundred Years of Forever" campaign called for an approach that would reach consumers as the number one audience. And that, of course, led to a mass media approach that relied heavily and with measurable success on radio and television spot announcements. But the plan designated other specific audiences, too--agricultural industry groups, real users of our research programs, the legislature, the alumni and university community, farmers and agri-business people. These groups were to some extent reachable through the mass media because they were exposed to the spot packages. But they also had the advantage of a campaign conducted in Prairie Farmer, our state farm magazine. We're fortunate to have that outlet for agricultural research information because in Illinois it reaches 94 percent of the farm families and 94 percent of the agri-business people. If you want to report agricultural research, that's the place to do it. Prairie Farmer carried 12 research features in two consecutive issues, each of them designated with the "First Hundred Years of Forever" logo, so they were identified as a campaign effort. That logo was carried over into our video tape spot announcements, was used in a slide presentation, and was the copy line that was a part of the television spot announcements.

Fifteen television stations aired one or more of our four research news features during prime time newscasts. It might be useful to you to see our message strategy. The beginning segment sets the stage and presents the view of the past as the old timer remembers it.

> "In 100 years, ag researchers have changed the face of Illinois agriculture. From wooden plows to steel plows. From manpower to electric power. From open pollinated corn to hybrid corn. From picking corn by hand to self-propelled eight-tow combines. All of this to make ours the best fed nation in the world. But these are only the first hundred years--the first hundred years of forever. As times change, problems will change. And so will the challenges confronting

ag researchers. And the business of ag research itself will go on forever.

"And it makes sense. A hundred years ago, research got underway to help a young, growing nation develop a science, the science of agriculture to feed the people. But then it was people, not scientists, who decided they wanted a university for the common man, and they wanted that university to do research and forge out that science. And today that same purpose exists because in the broadest sense, agricultural research is really the science of providing for man--food production, processing, distribution, marketing.

"That's why this station's programs and the people who implement them seem filled to the brim with an enthusiasm, a spirit, a conviction. This spirit helped early station workers fashion a research and education center out of Champaign's flat windy prairie. What was it that they used to say? 'One for the cutworm, one for the crow, one for the gopher, and two to go.'

"That was way back, but they're still planting corn by hand here, and today the Morrow Plots, the first experimental plot established on the Champaign County prairie, is the oldest experimental field in the nation. It has since been made a National Historic Landmark. The new information learned from the Morrow Plots and the experiment station had to be spread to farmers throughout the state. And extension agents worked hand in glove with researchers to spread the word. But despite the enthusiasm of agricultural researchers, change did not come easy.

"In the old days, they did not respect the university; they ridiculed it. They said limestone would make the land turn to cement. You wouldn't believe that. And then a farmer--one of the farmers who told me that--inside of four years cemented six farms, just quicker than lightening.

"The farms prospered. The farmers learned a lot, and they gained confidence in their new university."

In that first section, we were defining the scope of agricultural research and looking at significant projects at that time. I didn't include a lot of them, but probably one of the most dramatic stories to be told was research, largely done at Illinois, on whether farmers would use electricity on the farm. We had a mile line of electrical wires out in the country when nobody else had it. We had everything from dishwashers to automatic washing machines, ice cream freezers, and so on, which we gave to the farmers in exchange for keeping data on their actual use. It was terribly instrumental in convincing the electric companies in the state that farmers would use electricity. It's been documented that if that piece of research hadn't been done, we might not have gotten electricity on the farm as soon as we did.

We also wanted to emphasize the continuing nature of our research programs--how one development follows another. This is what I love about federal funding and what scares me about grant money--you can do research on something as long as you get money, and when the money's gone, you go somewhere else. I think one of the significant contributions of agricultural research is its stick-to-it-ness. The next part of the presentation deals only with our program in swine research.

"As late as the early 1900s, a large part of the American public earned its living through hard physical labor. Consequently, they were happy that the pigs of the day, fat little "cob rollers" they were called, supplied a fatty carcass. The pork fat supplies high amounts of energy to do hard physical labor.

"But as people's lives changed, so did their diets, and at the same time farming changed. Instead of everyone raising a few pigs for their own use and a few to sell, hog production became a specialized activity on some farms. And the first real hog producers had an eye for efficiency in their business, just as producers do today.

"The Illinois experiment station played a vital role in moving swine feeding from the primative corn-pasture rations that produced those slow-growing "cob rollers" to the efficient formulations fed to today's meat-type hog.

"Illinois researchers were among the first to introduce vitamins and antibiotics into swine rations, which made for healthier, faster-growing pigs. At the same time, research advances in genetics and breeding produced a leaner, meatier-type hog, the kind consumers began asking for after World War II.

"The type of hog has changed tremendously and the amount of lean tissue in the hog marketed today is remarkably improved over what it was 25 years ago. And again, we feel this is a direct contribution to the consumer, because it costs less to produce this hog than it might otherwise--if we didn't have this information.

"Another milestone development in the swine industry was the move to raising pigs in confinement housing.

"It so happens that here at the experiment station at the University of Illinois, some of the first work in this country on slotted floors for swine housing was accomplished. And some of the early research work we did has actually been the basis for guidelines of builders and swine producers in designing and building their own buildings throughout the country.

"And so, research continues to satisfy consumer demands and to increase efficiencies of production."

The final segment talks about the research that we most often talk about today--exploring the unknown. And that final paragraph stresses the need for continuing agricultural research in the future.

"But there's another kind of research, the kind that explores the unknown and pushes back the frontiers of science. And that's exactly what a research team in the Department of Horticulture is doing. Their work focuses on a new concept of food production and they call it cell-free agriculture.

"The driving idea for our group is to complement conventional agriculture with a new brand of agriculture, with a new type of agriculture that wouldn't use space, that wouldn't use soil, that wouldn't use large areas of water.

"In fact, the challenge is to grow food without plants, without whole cells. The key to the concept is the chloroplast, only a tiny part of a plant cell. Dr. Rebeiz and his team have taken the chloroplasts out of the plant and put them into a machine they call a photosynthetic reactor. This machine can be connected to a computer that monitors the condition of the chloroplasts.

"So we thought that if we can substitute ourselves for the rest of the plant, then we can get the chloroplasts to do just one thing: make food. They wouldn't have to worry about making wood, about making roots, about making leaves. Then all the energy would go into making food. So that was the basic idea. That's what we call cell-free agriculture.

"Accomplishments have been made. Already the research team has synthesized a chlorophyll molecule. And they've fabricated the photosynthetic membrane where the molecule lives. Rebeiz says that ultimately the sugars the chloroplasts produce can be used as raw materials to develop a wide range of consumer products, clothing, food, plastic products, and petroleum, for example. And Rebeiz sees hope for this research to contribute to the solution of the world food problem.

"It's just the beginning. And, anyhow, a 10,000-mile journey has to start with the first mile. And we are at the first mile. And before the process becomes industrial and we start producing food, it's going to be some time, a long time.

"Time. It's an essential and unavoidable element in each of our lives. And that's why we say ag research, the 'first hundred years of forever.' Because ag research is research for people. People pioneered the land-grant college concept that started it all, that made facilities and funds for research

available, that provided opportunities for scientists to document, to study, to explore. And we have to believe the need for ag research will continue. That there will be people here on earth for a long time, a long time to come."

We had history working for us. We had diversity of the research program. We were working hard to keep our message at the lowest technical level possible, to make it as popular in its appeal as possible, to show its relevance, to make the research as human as possible, to show how it touched on people's lives. That's what we were really working at in this campaign. The spot packages also were well received throughout the state. Six 30-second television public service spots were used by 23 television stations in Illinois, and that's practically all of them.

Based on information from the TV stations, we estimate the equivalent of $50,000 worth of television time was devoted to the campaign. In content, the TV spots paralleled the message strategy in the presentation above. At least 50 radio stations used public service spot announcements, and from their reports, we estimate the equivalent of $100,000 worth of radio time was devoted to the campaign. We have very little feedback in Illinois on what we get placed in daily newspapers. We heard a lot from our county agents throughout the state, so we're fairly confident that the material got used, although we don't have measurements.

The campaign was set to cover a four-month period from July 15 through November 15. And as is often the case, especially when things are out of control, the campaign lasted far beyond our cutoff date. The slide set was used throughout the winter months at meetings throughout the state; radio and television stations continued to air our spot announcements. But as far as those of us in the Office of Agricultural Communications were concerned (and we were really the implementers of the campaign), we were done with it. However, we got back in the business when the university's board of trustees requested a showing of the slide presentation at its April 1976 meeting. That was about six months after we thought we had laid it to rest. From the college's viewpoint, that was a real coup because we don't very often get our programs in front of the board of trustees with all attention focused on them for 22 minutes, which was the length of the slide presentation. (We always make presentations 22 minutes because they fit into the Lion's and Rotary Club noon programs. If they're any longer than that, they make everybody mad.) So we were going to the board of trustees meeting. Three of us checked out a truck, packed our gear, and joined campus administrators in far southern Illinois, where the board was to meet. And remember, the last few words of the slide set script is that the need for agricultural research will continue, that there will be people on earth for a long time to come.

Six weeks after that meeting campus administrators who had attended the board of trustees presentation asked our dean, "What if we put together a package on the total building and facility needs of the College of Agriculture? One package." Obviously campus administrators and, to some extent, the board of trustees were really looking for another way to skin

a cat. The College of Agriculture and the University of Illinois, in general, have had a tough time getting capital development projects funded by the state legislature. They looked at this presentation; they looked at the relevance of the research; and they said, "Let's not use the traditional means. Let's put together a separate agriculture building program and see if we can give it the palatability that would be necessary and see if we can communicate the relevance of the programs going on in that college to make this package appeal to the legislature."

Now for you skeptics of long-range planning--and I've often been one--I'll say that this was one time long-range planning really paid off. Panic and hysteria did reign. The college simply began to examine its own plans and proposals and in a very logical and orderly way in a fairly short time assembled a package of our building needs. We knew the elements of that package were important to the college's future, and we were confident about our requests because we had plenty of time to consider them as we put the package together. It was good that we weren't rushed in putting the package together because we certainly were rushed in developing our communication strategy. The first session with campus administrators included the president and the chancellor. We had more vice chancellors attend than the chancellor knew he had because they all wanted to do everything as quickly as possible. Their more specific directions to us included: a snappy brochure, a big show, and a publication that says everything, but is also short. We were assured that the hard facts would sell our program and that we had to start by telling people what they were getting. The administrators assured us that our prayers would be answered if we simply told interested audiences that the remodeling of buildings 925, 925W, 926, and 920 would result in new space of 24,500 square feet. The administrators said that we would get our money if we explained that this project was essential to achieve an efficient dairy research facility that would also provide proper ventilation and insulation, functional floors, stalls, watering devices, and cleaning equipment.

Having been given those specific directions, most of us in ag communications and the others who worked on this tended to flap around a bit for the first few days. We wondered what kind of an impression that approach and that strategy would make on labor leaders in Chicago, the dear little ladies in the Kankakee flower club, the shopper in the Peoria IGA, and our astute legislators. Most importantly, we wondered about the reaction of our client audiences--those who knew us well. We wouldn't have made any sense to them. The flapping soon subsided as we began to realize that we were face-to-face with the classic communication dilemma: Will we tell the audience why the project is important to us and what we're worried about? Or will we tell them why it's important to them and what they should worry about? A bit of horn locking went on for a few weeks. Time was wasted because we couldn't agree. A look at our slide presentation will show you which approach we chose and how we handled our message strategy. The following segments will also to a certain degree define the scope of the "Food for Century Three" proposal.

> "Your grocery boy. He's the last person, except yourself, in the chain of people responsible for putting a nutritious and

appealing meal on your table. He represents the point where production ends and consumption begins. But food production is a complex process. It may end with your grocery boy, but it certainly doesn't begin there. Before him, there were other store personnel, the people who deliver to the store, the processors, and the producers who supplied the raw materials--the meat and poultry that became pork chops, chuck roasts, and drumsticks; the vegetables, both fresh and frozen; the grain that became bread, rolls, and cereals; the milk, for everything from cottage cheese to ice cream.

"But even the producers aren't the beginning of this great food production process. The scriptures remind us, 'All flesh is grass.' Each of us depends on the earth for our most basic need: food. And unlocking the bounty of nature depends on knowledge, scientific agriculture based on research and technology.

"In just two centuries, a short period in terms of humankind, the United States has emerged as the greatest food-producing nation in the world. And agricultural research combined with the ingenuity and hard work of the American farmer have been major components in our nation's success. What started as an agrarian economy based on human need but largely unsupported by scientific methods has made a major turnaround. During the second century of our nation's development, scientific farming techniques helped food production outrace our population growth. During this period of plenty in the U.S., complacency set in, and some people asked, 'Why do research when we already have too much food?'

"Nature treats such complacency harshly. Agricultural problems never stay solved. The bio system, agriculture, must cope with a changing environment--weather, outbreak of pests and diseases, new economic trends, new social and political expectations from society.

"A recent classic example was the multistate outbreak of southern corn leaf blight. Corn yields went from a state average of 102 bushels per acre in 1969 to 74 bushels per acre in 1970--a 25 percent drop. Fortunately, the solution to this problem came quickly from research done during the preceding decade. Illinois hog producers are now faced with a similar problem, pseudo rabies. The disease causes severe financial loss for many Illinois hog operations, but the solution to this problem has not come as quickly. The lesson is this: Be prepared. In recent years, rising food costs focused attention on food production. As a nation, we've grown concerned, concerned about how we will produce food for century three.

"The challenge to assure an abundant supply of nutritious food underlies this $115 million building project from the Univer-

sity of Illinois Urbana campus. The project deals with a big idea that befits a great land-grant university. But it has to. Food production is a big problem. It's a problem that won't be solved through piecemeal efforts. The stakes are high, and the game is not one the world can afford to lose. The focal points for the program are the Colleges of Agriculture and Veterinary Medicine. 'Food for Century Three,' designed to be implemented during the next eight years, includes 21 new building projects, major remodeling of existing buildings, and the tearing down of obsolete facilities. It includes the acquisition of land for research and demonstrations, major pieces of fixed equipment, and research and extension centers in northern, western, and southern Illinois, as well as Urbana-Champaign.

"In announcing his support for the program, Governor James R. Thompson called 'Food for Century Three' an undertaking that could potentially revolutionize food production as we know it today.

"The governor has suggested that the capital projects in the program could be financed by a special issue of bonds. General revenue funds could be used to cover the non-bondable portions of the building costs.

"Facilities created by the 'Food for Century Three' project will give focus to five important program areas. The centers created will replace old, obsolete facilities that no longer provide suitable space to conduct research on the complex problems of today. About 240,000 net assignable square feet of new space will be made available for expanding agricultural and veterinary research."

This introduction led logically into discussion of the five centers to be established through the "Food for Century Three" proposal. And it also presented darn near all the facts and figures necessary. In each section we tried to get two jobs done. First, we tried to describe the research work that we were doing and the important problems that needed further work. Second, because what we were really after in this program is new buildings, we tried to point out the deficiencies of our existing facilities. The next segment will give you an idea of how that was accomplished. It includes part of the discussion about the Agricultural Engineering Center and part of the discussion about the Human Nutrition Center.

"The critical concern of agricultural engineering researchers is to conserve and more efficiently utilize the energy resources available to agriculture. Their efforts could have a lasting effect on both the food and energy problems. For example, substituting solar energy for fossil fuel energy where appropriate in agricultural operations and developing energy-efficient machinery for planting and harvesting will directly improve energy utilization. More efficient and versatile farm machinery will reduce the amount of grain lost during harvest, saving

more of the product into which researchers and producers put so much of their time and energy and resources.

"But today researchers at the University of Illinois can't even get a modern corn combine through the doors of the Agricultural Engineering Building. By all measures, that building is inadequate. Crowded conditions and inadequate noise control make teaching and research programs in the building totally incompatible.

"Even if farmers can maximize production and if processors can form the raw food materials into wholesome, nutritious food products, the food problem is still not solved. The food must get to the people. Again, agricultural engineers must be called upon to develop more efficient transportation systems and networks. And agricultural economists will be needed to develop more efficient marketing and management systems.

"But agricultural research is more than just food production. There's a growing need to learn about nutritional requirements of people, to develop new types of food, and to monitor food supplies to be certain that they're safe. Research is under way to compare the iron requirements of bottle-fed and breast-fed babies, for example. Other research is being done to explore the special nutritional needs of the elderly. Nutritional standards are being sought that will achieve optimum human health for all ages. Research with soybeans under the Department of Food Sciences is an example of the many types of new food products that can be developed. For years, it's been known that whole soybeans could be a major source of protein and calories; but they just didn't taste good. Research provided the key for eliminating that 'painty' taste and for developing a variety of soybean-based food products that are nutritionally sound and have appeal to people of many cultures.

"We've made a breakthrough. But followthrough is limited because headquarters for the research is an old steel building converted into a research facility. It's a makeshift situation at best. New facilities are also needed to increase man's capability to assure a safe food supply. The growing concern about consuming unnatural chemicals dictates that some agencies must monitor the components of diets. And the capability to monitor and the technology to do it must be based on research findings."

In structuring the final parts of the slide presentation, we slipped quickly into the wonderful world of advertising. In truth, we made it a little too slick. We rode the edge of "adiness" and we rode it on the wrong side part of the time. As time went by and the evidence of our success began to accumulate, this strategy received a fair amount of criticism, not from our intended audiences, but from those on campus who had had far less success than we had--our on-campus competition for state funds. The production was called highly produced, and it was assumed

that it was bad, slick, and a PR piece. And we didn't give a damn. In our opinion, those critics were right; but they also were not a part of the audience that we really had in mind at the beginning of this effort.

The viewers responded just as we wanted them to. Their responses were essential to the beginning of a campaign because we relied on many people to reach other audiences in face-to-face communication situations. I don't think there was a commodity group in the state of Illinois that year that did not pass a resolution at its annual meeting. Even the horse radish growers did. They aren't our biggies, but we got them to do it. The poultry people, Farm Bureau, NFO, the Grange, all the farm organizations, and I think every agricultural-related group came out and supported us. They'd seen this program and they'd been touched by the mass-media campaign that was associated with it.

> "Exciting possibilities from an exciting program, a program that is right for the state of Illinois. No state has greater potential to contribute to the world food supply than Illinois. Nearly one dollar in every five is closely tied to agriculture. And research is the base upon which the industry was built. Above and beyond what we use at home, Illinois exports more than one-and-one-half billion dollars worth of agricultural commodities, making it the nation's leading export state. The rewards reaped today stem from past research. The rewards future generations will reap will come from research currently under way and from the research of tomorrow. The nation can't go forward merely on past investments.
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> "Already there are signs that yield increases are leveling. And at the same time, the best minds in agriculture throughout Illinois and the nation say there are still plenty of advances to be made if scientists make the right research breakthroughs. For example, one report projects that corn yields and beef production can increase 60 percent by 1985; soybean yields can increase by 40 percent.
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> "All this can happen and more, if wise investments are made in agricultural research.
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> "The 'Food for Century Three' project is a challenge in our time for the Urbana-Champaign campus of the University of Illinois, a challenge in research and education on food, its production, and its use. The project is big, but it fits the university's tradition of service to people through education. If it is implemented, it will place the university in a leadership role in an area important to Illinois, agriculture, and food. And it will help assure that people throughout the world have enough to eat. Food research does not recognize geographical boundaries. Breakthroughs in agricultural research at Illinois can be applied worldwide to help to produce more food.

"'Food for Century Three.' It's a way to assure that there is plenty of food for your family and all families--safe, high-quality food at a cost we can all afford. To all of us it's food for century three."

Now you may be wondering: "I guess I can kind of understand how all this relates to what this program promised to be." I'll try to answer that question. But I'll answer another question first: "Two campaigns in Illinois--so what? 'Food for Century Three' campaign--so what?" So far we've had projects that have gone through the legislative process and have been approved totalling more than $43 million. We now have a new swine research center, a new basic sciences building for vet med, and two new research farms in western Illinois. The new ag engineering building is under way and it's a really complex facility. The new dairy research facility has been completed. That's what we were after. But above all, we got understanding; we got concern; we got appreciation that has lasted for more than five years now. And this effort isn't completed yet. In my opinion, the planning and effort expended in conducting these two efforts are in no way different from what we at Illinois try to do when we run across a new piece of research, when we issue a progress report on research, or monitor it through to completion and report the results. The major difference between those situations and our two campaigns was that our objective was much clearer, particularly with the latter campaign. Our objective was a great deal more specific. It was more immediate. It was more easily measured. When we report a single research story, those elements are rarely prescribed for us. And we rarely think through them before we begin grinding out copy.

I want to reinforce a couple of points again. I work for a university. Our university doesn't have a lot of money. A lot of the research we report isn't hard news. Consequently, we find increasingly that we report research with an eye toward getting the story told so that the work will be funded or new work will be funded. It's a part of life today at the University of Illinois and on many other campuses. The stories that report to our client audiences aren't the kind of stories that routinely bring the major network crews out of Chicago to our prairie campus in the hinterland. In the College of Agriculture we do not routinely go to the moon. We do not regularly discover a new life form. We don't often revolutionize some major aspect of corn and soybean production; we do that every once in awhile. But we do several other things. We learn how to reclaim land that has been strip-mined. We learn that none of the products tested that were designed to get rid of swine waste odors did the job. We do learn another step in the unraveling story of how to successfully feed dairy cows automatically as well as master dairymen did when they were free to practice the art of good husbandry. Those stories, to use a word that I am certain came from Washington, DC, "impact" our client audiences. And it seems to me that's when we have our greatest success; that's when we get stories used and get responses from our intended audiences. We've severely violated much of what I learned in our basic journalism classes. But we've almost always earned a pretty decent grade in Advertising 381, the campaigns course at Illinois.

This is an approximation of the approach that I'd like to see us use when we're working with a single piece of reportable research. In my mind, reportable research is narrower than research. If you read a research report, ask, "Who cares?". If your answer is, "Nobody, other scientists, or Senator Proxmire," you've got a piece of research that should be filed under "research better unreported." That does not mean the research is bad. That does not mean that the work isn't important. It simply means that you probably don't want to use the mass media to report the benefits of that work to any of those three interested audiences, even if the dean says it will sustain funding. But when you ask, "Who cares?" and begin ticking off real categories of people, and when you know those people are best reached through mass media, then you're on the track of reportable research.

If you get the right answers to the second question, "Why do they care?", you're entering the gates of advertising. You're beginning to talk about the benefits, the relevance of university research. Advertising academicians contend that people go through a process: they become aware; they form attitudes; and based on those attitudes they take some kind of action. They also contend that an advertisement has four jobs to do: attract attention, build interest, create believability, and call for action. And they see copy and ads oriented toward benefits as a way to get those jobs done. Simply put, this means that good ads and commercials act quickly to answer the potential readers' or listeners' inevitable question: "What's in it for me?" And isn't that the question you and I have every time we consider anything we read--a news story, an advertisement, a feature story, or whatever? I contend that the same is true of good science writing. If the lead doesn't get that job done, you've got one of two problems. Either the gatekeeper at your media outlet will give you the gate or your potential reader will. It really doesn't make much difference which problem you have; the result is the same.

Now, if you're ready to roll up your sleeves, tilt down your green visor, and get on with promises, take caution. Remember the processes of awareness, attitude formation, and action, and advertising's jobs of attracting attention, building interest, creating believability, and calling for action. Your intended audiences are going to form attitudes, and they can form them on empty promises. They're not shy about it. Or, you can be effective in building and sustaining interest and, more important, in being ethical in giving your science story believability. Those elements can provide the basis for the attitudes your clientele forms. Finally, if the research is conclusive enough, readers need and want to be told what action to take. In some cases, you may be making specific recommendations. In other cases you may be hinting that they ought to be looking for further developments as scientists look for other answers.

I like to keep the elements of an advertisement or commercial in mind every time I work on a research story, a two-page release, a 40-second news clip, a major campaign, or whatever. Rarely does a single reporting get people through that entire process of awareness, attitude formation, and action. And rarely does a single reporting need to do all of the

jobs that an ad must do. Instead, I like to think of each piece of research we're monitoring as a loose-knit campaign based on the information needs of clientele audiences. Those campaigns often don't have high visibility, and I worry about that. But each element in the campaign should build on earlier elements. If our media strategy is right and interested audiences are being exposed, that's sound. If our message strategy is right, then we stand a fair chance of getting the readership or viewership we want. Subsequently, we stand a fair chance of achieving the influence we want.

Communicating University Research: Researchers' Reflections

THE PROBLEM OF INFORMING THE PUBLIC ABOUT BASIC RESEARCH

Dr. Victor F. Weisskopf
Institute Professor Emeritus
Massachusetts Institute of Technology

> "He who acquires knowledge without being able to teach it clearly, has not learned anything." --Thucydides

I don't think I need to tell an audience such as this one that the public should be informed about research going on at the modern research laboratories, university or otherwise. The public is not well informed, neither about the content of what's done nor about the significance of it, and certainly not about the relevance of basic research. One of the few positive things about today's civilization is that we have gained so much insight into nature, much more than in any other period. Basic research is, of course, also important to society, but not only because of its direct applications to new inventions. Rather, it is because basic science determines the intellectual level of the scientific technical establishment. That's where some of the hardest unsolved problems are solved, and that brings out the people who have ideas. Without this, the whole technical establishment of applied science would be on a lower level.

There are very interesting historical examples of this. When certain nations in the past have experienced high degrees of industrial capabilities--such as Germany in the late nineteenth century and in the beginning of the twentieth century, England in the nineteenth century, and America in the last 50 years--the level of basic science has been high. These things are always parallel. One should learn from this.

How can one inform the public? And what are the difficulties? The first problem is the complexity of the topic. It's quite clear that modern science deals with very complex concepts unknown or at least very unfamiliar to the public. This is due to rapid advancements in scientific areas. It is also due to the special language that scientists use. These two things are probably connected--things go so fast that scientists have to use acronyms, language shorthand for concepts that have significance for the scientists but not for the public. Often the scientists are not even aware of how misleading and confusing the professional language is to the lay public.

In popular presentations there is a tendency to oversimplify if you want to explain research to the public, and this oversimplification brings a lot of misunderstanding. Also, the scientists are not really the best judges of what is difficult and what is not difficult, of what concept should be simplified and what should not. Indeed, if you look at the popularizations of scientists, in many cases they oversimplify what they shouldn't, and they do not simplify what they should have simplified. Of course, the science writers are on the other side of the fence. They know well what the public needs, but many of them do not know what is relevant in a new development and how it is connected with the rest of science.

The second difficulty is a restriction in science writing to what is "newest." Actually, you cannot understand the significance and the relevance of a discovery if you don't know previously discovered insights. This emphasis on the newest is really quite bad. It goes through the whole range of scientific publications. An example is Scientific American, whose articles are very hard to understand. They deal with some recent advances, and do not tell enough about the basic concepts. The magazine is supposed to be popular. It's understandable for the writer of the article; I'm not even sure about that sometimes. It's understandable to people who work in similar fields as that of the article; these are the people to whom the writer shows his or her article, usually not to people outside. In fact, Scientific American may not even be understandable to the editors. There are also several other popular magazines, such as Science Times, Science 81, Discover, Science News, that concentrate on the news and do not care about presenting old ideas--that is, ideas that are necessary for understanding the subjects. This is true of all the publications, and also, by the way, of TV shows. It is also true of the many publications that universities put out about what they do. For example, I would like to see in one of these university research reports an article by a physics professor on what quantum mechanics is.

The third difficulty in informing the public about research is an emphasis on the results instead of the problems. What is reported are new results and new insights, some of which, as we know, sometimes have to be revoked later on. This does not underscore the importance of science in action. What is essential in science is not so much the discovery itself, but the process through which you get the discovery. You have to explain the whole situation in that special field; you should tell about unsuccessful attempts and wrong conclusions, too. That is science in action. There is not enough science in action, although certain "Nova" programs did attempt this.

Many of the discoveries made in modern fields are really not as important as they are advertised. Too often there is talk about a "breakthrough" when there was only a little step forward. For example, in particle physics, there is always talk about the discovery of the ultimate particle, or the final great unification of all forces of nature when, in actuality, some new quantum state of a quark system was discovered, or when a certain similarity between two of the forces was found. Furthermore, the more important side of those discoveries is not the finding of the ultimate law, but rather the discovery of new types of physical phenomena, new ways of behavior in nature, which usually are not understood within the framework of our present knowledge. And these are the most interesting things.

In particle physics, my present field, what is interesting are all these mesons, quarks, and heavy electrons that have been found, although we don't even know what they really mean. Science has enlarged our horizons. We know more about the behavior of nature under unusual conditions. It's like discovering a new continent. I have often compared the progress in particle physics with Columbus's trip and said there are three kinds of physicists--the ones that build the accelerators, always underestimated

in importance; the ones that make experiments; and the theoretical physicists. The ones that built the accelerators correspond to the engineers who built the ships and the captains who sailed over unknown oceans. The experimenters are those who, when they landed on the other side, jumped from the ship and wrote down what they saw, incredible as it seemed to them. And the theorists are those who stayed back in Madrid and told Columbus that he would land in India. Theoretical insights are very important. But equally important is the work of the instrument builders and the experimentalists who study nature under unusual conditions, under conditions that are very different than those on earth, and find new "continents" of natural phenomena.

When Glashow, Weinberg, and Salam got the Nobel Prize, they were correctly celebrated as having predicted so-called neutral currents in radioactivity. And that was later found experimentally. To understand the significance of this discovery of neutral currents, one has to know the whole development of this field. One must know that all radioactivity up to now was a consequence of non-neutral, charged currents. There are many examples like this also in solid state physics. What is a triple point? Most people don't know, but many of the new developments deal with it. So science reporting must deal with older topics.

There are other examples in quantum mechanics. One is the color of incandescent matter. Everybody knows that if you heat up a piece of coal, it is first red, then yellow, then white. How many people know why? It was not understood before 1900. It was just as mysterious as the theory of memory is today. (We don't know what happens in our head when we remember, and we don't know what the memory does.) Yet to know where the color of incandescent matter comes from is essential for the understanding of the progress of science today. But no journal would ever print a presentation of such "old stuff."

Another example is the specific properties of atoms. Why is iron hard and neon a gas? How can you talk about modern discoveries without knowing about this? Again, this is "old stuff" that nobody wants to write about.

Then there is the general misunderstanding of the significance of relativity and the uncertainty principle. Einstein has not made everything "relative"; he has shown that the laws of nature are absolute and independent of the frame of reference. Heisenberg has shown that the quantum state is well-defined, but only the old fashioned classical concepts, like location and speed, are uncertain. We must show to the public that quantum mechanics is the basis of all phenomena that we observe in daily life. It explains the specific properties of elements, why neon is a gas and sodium a metal, although the difference in numbers of electrons is only 10 percent. It explains the hardness of solids, the color of things, and so many other daily experiences, such as the fact that the same flowers blossom every spring.

An additional example is the quantum ladder, which is again quite essential to the layman in understanding how the different discoveries

in physics hang together. I cannot understand how one can talk about particle physics to a public without using the concept of the quantum ladder that describes the relation between atomic, nuclear and subnuclear physics. The layman needs an ordering scheme of the different parts of science so that he or she can say, "Ah ha, this is from here; that is from there."

It is interesting to observe that the situation is better in astronomy than in physics and chemistry. Biology is in an intermediate position. Somehow, topics such as the "big bang," black holes, neutron stars, or quasars attract the public. It may be because the origin of the universe and the cosmos excites the public's imagination. Perhaps it is a quasi-religious feeling of awe and humility toward the greatness of the universe. Biology, of course, deals with life, with questions that have a more direct connection with our personal experiences.

How can we improve communication about research? First of all, with more reporting. This means including more of what I called "old stuff." The point is that old stuff is interesting, and it's easier to make interesting than some of the new material, if you don't have the old stuff as a basis. In addition, I believe there should be regular science columns, which could report not only the new discoveries, but the interesting background phenomena such as the quantum ladder. Television programs, too, should be doing a lot better in this respect.

This brings me to the need of a journal. We do have the Scientific American, which serves a certain purpose. It is interesting for those people who work in a particular field and helps them get oriented as to what has happened in similar fields.

These articles are good and bring out a lot of interesting things. But, in general, they cannot be understood by scientists of different fields. We have nothing between the Scientific American and Science News, Science 81, and Popular Mechanics. That means we do not have a journal that has the character of the Scientific American but that is understandable to the intelligent layman and that gives you more than a glimpse of the newest. What is needed, in my mind, is a journal that has articles about old stuff and new stuff, that is understandable to somebody who has had only high school physics and biology. Such a journal is possible. There are examples abroad. In Russia there is a journal called Quantum that is directed at high school students. It is, I think, an ideal journal, but it has one great drawback--it's written in Russian. As far as I am concerned, someone should translate it. In England there is The New Scientist, but I think it is, like Science News, essentially devoted to recent discoveries and science politics. So we are in need of a journal. And I emphasize again, the old stuff is more fascinating than most of the new.

One very important way to improve science communication is through close collaboration between scientists and science writers. The reason is obvious--scientists don't know what is understandable and what is not. Therefore, you need somebody else. You need the science writer who

knows what is understandable. The science writer's problem is that he or she often doesn't know how the new developments are related to previous work; he or she frequently has difficulties distinguishing the relevant from the irrelevant.

Often a science reporter comes and has a telephone interview or a personal interview and then goes and writes an article and usually promises to send it back, but doesn't. Nothing would be better than having a scientist and a science writer really work together at communicating science. I have had many promises, but nothing ever came of them. I am not blaming either side. Such collaboration could work for magazine articles and news items. In television, things are a little better, simply because in TV you've got to have other people working with you. A scientist can write an article, but he or she cannot make a TV show without professional help. That automatically gives you the right combination, and I think that's the reason some good TV science shows exist, such as the Bronowski series, "Cosmos," and some of the "Nova" shows.

A lot could be done and almost nothing is being done in this area of real collaboration--sitting down and writing together. The scientists should be humble in recognizing that they are not very good judges of what can be understood by the lay public; the science writers should be more humble in recognizing that they would be able to do a much better job in tandem.

There is another important point to be made. It is terrible how little recognition popularization gets in the universities. You have to do it, so to speak, after 5 o'clock. It is not recognized as important; it is certainly not recognized in promotions. In other words, the action of popularization--writing a popular book, making a TV show, or writing a magazine article--must be considered as one of the main duties of a scientist. Your status as a scientist in the scientific community should be improved if you are known as a good popularizer. That was so before. Jeans, Eddington, Born, and a number of other people were famous for their way of presenting science. Now this is no longer so. An example is Carl Sagan, who has become despised among his colleagues because of his work with the public.

The same is true of the science writer. Science writers, with some impressive exceptions, are not well enough informed. This, I think, is also due to their lack of status among their colleagues in print or broadcast journalism and, perhaps more important, among those in the scientific community. That has to be changed. Science writers and TV people should be invited to conferences, not only as observers, but as members of the scientific community. There is nothing more important than status. More than money, status makes people work and take things seriously.

We also have to consider the education gap, which is like the missile gap or armaments gap between the Soviet Union and the United States. It is a shame how much more science is taught in Russian high schools. The European high schools are better than those in this country, but not much.

In my time, they were very good. I had to go to two physics courses--one at the age of 11 and 12 and one again at 16 or 17. And I really learned something. Today, I'm afraid, Europe is imitating what is bad in America but not much of what is good. Among other things, the Europeans are accepting this idea that science is too hard for high school students. This is the new education gap that we must do something about. And, of course, it is deeply connected with our problems in communicating science.

I cannot conclude without mentioning some of the psychological factors that have increased the always existing barrier between science and the public. These are the dangers of war, of pollution, and of depersonalization. These three dangers are symbolized by the nuclear bomb or the nuclear reactor, industrial pollution, and, of course, depersonalization by the computer.

Clearly, these three things are foremost in people's minds and have created the impression that science is bad; it may be interesting, but it's dangerous. The problems connected with this are beyond those we've discussed today. But it is frustrating to try to describe to the public the beauty and depth and significance of science, in view of these real threats. Therefore, the humanization of society and the reduction of the danger of nuclear war must be the first aim of everyone--scientists, humanists, reporters, citizens. This century will be known in a few hundred years either as the age in which science acquired the widest and deepest insights into the universe or as the time of preparation for the greatest catastrophe, with science as the main culprit. Let us hope and act so that it will be known for the first.

Question: What about the problems that TV, magazines, and newspapers have? They're going to write what sells and I haven't seen anyone address that problem. The surveys that show people are interested in science are no doubt picking up the people who are interested in "gee whiz" science and the stuff scientists are not happy about seeing in the public sector.

Answer: First, I have nothing against "gee whiz" science reporting. Indeed, the title of my popular book is Knowledge and Wonder. Now, "wonder" is just a different word for "gee whiz." I really think you can make old stuff into "gee whiz" material if you want to do so. Secondly, I really don't believe that from a commercial point of view what is done now is really the maximum. By going on with this kind of very short "gee whiz" material here and there you excite a certain interest, but not a lasting one. You could do much better than that. The interest in science will increase. You will have the "gee whiz," but you will have much more to publish. I personally think that a journal, as I suggested earlier, would be a very good business. This is the old problem of the creation of interest. People say you have to follow what the people want to read, but actually that is only partially true. There is also another component. You create the interest by emphasizing certain things. You publish what you think they want and then they will want it if it is of good quality. After certain difficulties in the beginning, of course, the broadening of science interest is possible. And, of course, better quality will

increase the interest in science and therefore will make this a paying proposition.

Question: On more occasions than I would like to admit I'm confronted with the closed door of a scientist who doesn't want to talk. Is that going to change?

Answer: Yes and no. This, of course, has to do with the point I made about status. This problem again requires a collaboration of both sides. I believe there are certain scientists who will never change and will always have a closed door. They don't want to be disturbed, and I have nothing against these scientists. They're usually fanatically devoted to their work, and that's good. But there must be other scientists willing to talk. I think it's getting better. There are more scientists who see that problem. You have to find the right scientist. It's difficult because there are two types of scientists who think that this kind of publicity is necessary: the ones who are able and the ones who aren't able to transmit to you what they do. So it's a matter of natural selection. You have to find scientists who want to do it and who can do it. That's not easy. But maybe you might find each other by mutual help.

Comment: Consistently I get the argument from scientists that their colleagues will ridicule them if they appear in the local national press. And this is an unfair assessment.

Answer: Yes, it's an unfair assessment, although it's partially true. But a scientist has to say, like Carl Sagan, "I don't care. I'm doing my duty." Every politician knows that he or she is going to be attacked by some people, and scientists should be accustomed to that, too. I'm also attacked. I'm known as the oversimplifier, you know. I'm told that what I say may be understandable, but it isn't quite true. To which I say, "Well, what you say to the public may be completely true, but nobody can understand it." You have to find the right middle way. By the way, one point I failed to mention is the funny terminology of modern science. I spoke about acronyms, but I should also mention this funny humor, such as saying "quarks have charm." I personally think it's very bad. I tried to avoid using the word quark, but I was unsuccessful. After my student days I worked with very young and enthusiastic physicists in Copenhagen. And they made jokes about everything. Bohr used to take new people for a walk to talk to them alone and I told him I was taken aback by all the bad jokes about these wonderful things. He said, "You know, there are certain things that are so serious that you can only joke about them." This is partially the reason for this whimsical approach and the silly terms like charm, beauty, strangeness, and so on. It's kind of a discharge, you know, because they are really doing something that has an almost religious character for the true scientist.

Question: Do you think the U.S. government should imitate the Soviet government in publishing a science journal?

Answer: I don't think the government should do it.

Question: If nobody else will do it, do you think the government should do it?

Answer: Yes, although I always distrust things that are done by the government. But it would be better than nothing.

UNIVERSITY RESEARCH: MEDICAL AND LIFE SCIENCES

Dr. Richard T. Johnson
Dwight D. Eisenhower Professor of Neurology
and Professor of Microbiology
The Johns Hopkins University

As a research worker, my laboratory focuses on the relationship of viruses to chronic diseases such as multiple sclerosis and amyotrophic lateral sclerosis. This has recently been an area of interest in the popular press. On the other hand, I'm a physician in charge of a multiple sclerosis clinic and I also see patients with a variety of other neurological diseases. Therefore, I feel an obligation, in dealing with the media, to protect or to assist patients. So I can speak from two vantage points that have some common parallels and also many differences. This poses problems for some of us at medical institutions in dealing with the media that may be somewhat different than the problems others might face.

The attitudes toward the media have changed. Twenty years ago consorting with the media at all was considered bad form, and you might be ostracized by your colleagues. The basic attitude was that if you were smart enough to get money to do research, you didn't have to answer to anybody for it. You communicated with your peers through publications and got your grants reviewed, and anybody else approaching you for information was considered an intrusion and would be destructive to your scientific reputation. That view has changed for two reasons. The first reason is that there has been a shortage of funds. It's no longer possible for the director of the National Institutes of Health to appear before a congressional committee and be asked, "How much money could you use?" Today we need help in getting support for medical research, and that help has to come from the public. Therefore, "going public" with research results is seen as a way to gain public support, to help the public elect officials who will support research and inform the electorate that support is needed. In this way, the public can become the constituency to lobby for research funding.

The second reason for a change in researchers' attitudes toward the media is probably more important--the general belief in accountability in our society. That has evolved not only in politics, but also in universities and research laboratories. People realize that the public is paying the bills and therefore deserves to know what the product is. This general feeling of accountability is even more important in terms of the increasing openness of people in research to talk with the media. This openness potentially can be one of the greatest allies of research. The problems, of course, are the misinterpretations that can occur and the inadequate information that is sometimes given. There may also be problems with one's academic colleagues when research results appear in the media before they have gone through peer review and appeared in scholarly journals. The practice of peer review before releasing results

is one of the things the media object to the most--why is a research report essentially kept secret for months? People in the press know it takes only a day to get a story through the city editor, so they don't understand why it takes months to go through journal editors. The fact is that it takes months because a given report goes out for peer review, which is a way of avoiding mistakes and inaccurate information before the report becomes public.

Another change has occurred in the relationship of doctors and patients that has affected doctors' attitudes toward the media. Historically, just as the research worker felt nobody should interfere with his or her work, a good physician played father figure and told patients very little. The physician patted them on the head and said, "Don't worry; I'll take care of it." If a patient had cancer, the physician never said "cancer," but might explain that the patient had "a little growth." If a patient had multiple sclerosis, he or she was often not told. Patients weren't considered strong enough to accept those hard words, so you said, "There's a little inflammation here," or "Something is wrong with the insulation on your nerves." And that was all.

Why has that changed? It has changed for a number of reasons. Certainly, one of the things that changed was the development in the 1950s of cancer chemotherapy and pharmacology. You couldn't ask health professionals in these areas to see a patient unless you had told the patient that he or she had "cancer." You had to use that word. You had to tell the patient the truth. The patient and the physician then had to work out what to do about the diagnosis. This forced a change in attitude of both physicians and patients. Patients by and large now want to know what they have. They want to know what their doctors are thinking. They want accountability. And they deserve to know. That's what they are paying for. That's what they come to see doctors for. In the long run, I think the candor that now exists between patients and physicians is a great improvement. Patients with multiple sclerosis tell me they felt the greatest anxiety when they were not told the diagnosis or during that long period when the diagnosis was uncertain, which is often the case in that disease. Once the diagnosis is certain and they find out what they have, although they are shocked, they find that with education, they can handle their problems better, can deal with their disease in a realistic way, and can live a better life with less anxiety. The change requires education, just as educating the public about research can change its attitudes toward research. Again, in this respect, the media can be a great ally. It takes a lot of time to discuss the details of a disease with patients. It helps if they have a basic understanding because of what they've read in the newspapers or seen on television. Unfortunately, it's in this area where the media are often harmful. They recognize, I think, some responsibility for telling the public the truth about research endeavors, but they often fail to recognize a responsibility to the sensitivity or the problems of patients. They often raise false hopes, and that's not a trivial matter. Many people say it makes no difference if some quack cure is publicized; it's news and makes good copy. The fact is that millions of dollars are spent on unproven or even dangerous therapies. Such reports often divert the patient from seeking proper treatment for

the disease. And more important, looking at it from the vantage point of a neurologist who takes care of patients with chronic diseases and limited life expectancies, publicizing dubious cures takes time away from patients' lives. Life is finite for all of us, and if a patient has two or three years left, spending six months of that time chasing quack cures is tragic. This fault, I think, often lies with the media.

Examples of this are evident in even the most responsible reporting. Certainly this is one of the greatest problems with television because television is too short and too concerned with visuals. There's not enough information given and there's a tremendous concern about what a story looks like. Two years ago the CBS evening news ran a piece that basically turned out like an ad for the use of cobra snake venum for treatment of amyotrophic lateral sclerosis, a disease whose victims have a very limited life expectancy; so they should spend their limited time as wisely as they can. But who could resist the picture of Lou Gehrig standing in the middle of Yankee Stadium with his hands withering saying, "I am the luckiest man in the world." That scene fades to one of serpents being milked--now that's good visuals. It's also poor information. It caused thousands of people to waste money on airline fares and precious time seeking a treatment, the results of which had never been submitted to critical peer review in any scientific journal. Subsequently, two studies showed the absolute worthlessness of the therapy and one showed possible detrimental effects. That sort of limited coverage is inherent to television.

Newspapers could obviously do better. They've got more space; they don't have to rely on what looks good. And yet the press often gives very inadequate information. It often makes something that isn't news into news. An example of this arose a few years ago when a number of newspapers around the United States ran headlines saying that Salk vaccine for multiple sclerosis works. There have been, over a number of years, attempts to treat multiple sclerosis using a fraction of brain tissue to cause immunological paralysis and halt the symptoms of the disease. In an experimental disease where there's an allergy to brain tissue, this kind of immunological paralysis has been demonstrated, but the experimental disease is not multiple sclerosis. People have on several occasions tried the same sort of material in multiple sclerosis patients without any successful results. It was decided several years ago that it would be worth trying large doses in a limited number of patients to see if the treatment would work. Jonas Salk was willing to undertake that. Lilly produced a brain extract that was purified and met standards for scientific investigation and entered into stage one testing. The initial stage was to give this material to a small number of volunteers with very advanced disease who were willing to try anything and to see in the first stage how the material affected them. This was nothing more than a human toxicity study. The announcement of the study by Lilly and from the laboratories was that they had passed through that initial stage and that these patients had not died when injected with massive amounts of this material or become suddenly worse. That was the story. And yet a number of papers picked this up and misinterpreted its meaning. Not only

were the laboratories flooded with calls, but in my clinic we received dozens if not hundreds of calls from people asking if they should buy an airplane ticket for LaJolla, California, and get this marvelous vaccine they'd read about in the paper. Some of them flew to California and found out that there was, in fact, no study they could register in. It's this kind of inadequate information that often is detrimental to patients.

What suggestions can I offer to those of you in public relations or in the media? One is that the validity of a story should be checked by the reporters or the public relations official. Is it published or accepted for publication in a reputable journal? That's a pretty good criterion. Being accepted for publication in a journal is not what I said--you can publish virtually anything these days if you try hard enough or send it to enough journals. So there has to be some knowledge of what is reputable and what is not. It is important for reporters to know if the story has been released or endorsed by a reputable university. That's where the public relations department of universities becomes very critical. You ought to know the faculty, you ought to know what's going on, you ought to be able to check a story out. Even if a story comes from a reputable university, some control is needed within the university. We have in all universities some senior members of the faculty who are over the hill and some junior ones who are not as reliable as one might hope they would be. In this way public relations professionals can be a great assistance. Having the media deal exclusively with the public relations department is a good idea. In my university, it's not acceptable for researchers to pick up the telephone and call the media; we're supposed to pick up the telephone and call the PR office. The PR office often calls us. I think dealing through an intermediary in that respect is helpful both as a safeguard for the scientists, the physicians, and the patients, and as a safeguard for the media themselves. Reporters also should learn that it's helpful if they make friends. All of us know reporters who call and say they've heard something and ask if it's any good, even though it has nothing to do with us. They know somebody well enough to trust that they can get their own confidential peer review, or that this person will help them find what they need to know. Reporters are often somewhat reticent to do this. They feel they have to maintain an adversary position. Yet they do much better when they develop friendships and deal with the scientific community in a more straightforward manner. One problem that comes up not so much with university writers, but certainly with reporters, is whether the reporters have read about their subject and know what they are talking about. You expect people to have done a certain amount of homework and you're very put off by the person who comes in and starts out an interview by saying, "Multiple sclerosis, that's the same as muscular dystrophy, isn't it?" I've had that happen more than once.

On the other hand, as an example, a number of years ago we had published a paper on a very rare disease, so it would not seem to be particularly important to the public. The article came out in the New England Journal of Medicine, which is a reputable journal. A science writer called me and said that she had read the paper. It turns out she takes 10 journals

and reads them all. She said the article caught her interest; she asked if the virus that had been recovered from this chronic human disease was the same as the virus that had contaminated the Salk polio vaccines during the 1950s. I was impressed because we had carefully avoided making any reference to that similarity in the paper; we had no evidence that there was any relationship on the basis of the preliminary studies, and the amount of terror one could place in the hearts of mothers and young people in this country who had gotten that vaccine was considerable. She came and talked to me about it. I said, "You know, I don't think you ought to write that." She said, "Well, you know that has to be my decision; I'm a reporter." I told her why I thought it would be unwise to print that part of the story. She wrote an absolutely accurate article on the virus, about how it was rare, but might relate to other things. No comment was made about the possible similarity with the virus that contaminated the polio vaccine in the past. Fortunately, it turned out that was not the case. Since then she has been a trusted friend. She calls me up and asks me about other sources; I tell her what's going on any time she wants to know it. Being informed and having done your homework is a great plus. In contrast, a reporter called a couple of weeks ago and wanted to write on something else. I was busy and said I could give her a couple of things to read, and then we could get together to discuss any questions. On the telephone she said to me, "Read? You want me to read? I just want to talk to you." That is the opposite situation, I think. I think because many of us are also teachers we get very upset with people who want everything simply spoon-fed to them and haven't done some reading ahead of time.

Another important point is to remain aware of the implications of publicity to patients. This also involves basic science investigators who see something that appears relevant to clinical medicine, but who fail to appreciate, as the media fail to appreciate, the implications this may have in terms of human suffering. I do not want to have the medical profession put into a position of protecting our patients from heartless media. I think it would be far better if the media could work as an educational extension for the betterment of scientific communication.

Comment: The Cambridge City Council held a series of public hearings on a proposal that recombinant DNA research not be conducted in that community. The Boston Herald Advertiser, now defunct, sent someone different to every one of those public hearings, and every time it assigned someone new to those hearings that person would call me on the phone and ask, "What is recombinant DNA?" One of them called and said, "Listen, I've got to cover this Cambridge City Council meeting tonight on this DNA stuff and I don't know anything about it. What is it?" I said, "Well, I can tell you very quickly if you've got five minutes." He said, "Great, Bob, go ahead. But before you start, don't tell me anything hard." This somewhat states the attitude--"don't tell me anything hard."

Question: On the problem of publication in reliable journals, we in public information offices face newspaper reporters who call up and say, "I hear that there's a certain line of research underway. I want to

interview somebody and get a story on that." We say, "Well, the researcher respectfully declines on the grounds that he has not yet had that article published." And then we are met with people from the news media who say that's simply a device enabling establishment scientists to control people they don't like. They say that medical politics goes on a great deal during the peer review process. Someone submits a paper and referees look at it and the decision about whether that paper should or should not be published is based on issues other than the science that is contained in it--personalities, the treatment that former graduate students received at the hands of their mentors, competition for available funds within the various institutes of health. What do we say to reporters who say that is simply a device and they won't tolerate it? It is our policy at MIT to seek concurrent publicity at the time of reputable publication. We try not to deviate, but it's hard. What do we say to those people?

Answer: Reporters must pass their articles through their city editor. Their articles go through peer review. Now, admittedly, the time frame is a little different; they can do it overnight. I don't know of any science writers who write their copy without having someone else read it. Maybe there are some. Most science journals use outside review. In newspapers, which have very short publication lives, articles go through an editorial staff within the paper. On the other side of it, you hear of scientists with rather non-validated cures who say that the establishment won't let them publish their work. That's nonsense; you can publish almost anything. Yes, some very famous pieces of work have been turned down by reputable journals, but I can't think of one really good famous piece of work turned down by a reputable journal that didn't get published in another reputable journal. Journals are capricious and they turn down good material. We hope they also turn down all bad material. I think that good material gets published in good journals. It isn't that the alternative to publishing in Science is publishing in the evening newspaper. The alternative to publishing in Science is publishing in Nature.

Question: We have had a couple of situations in which we observed the rule of reputable journals, but then had a drug company working with the project in a very legitimate way want to do a very big spread before the results had been published or verified. It is sometimes very difficult to keep a drug company from doing that. Do you have any type of policy where the researcher has some sort of control over what the commercial press officer does with your choice material? Have you considered that?

Answer: I've never worked in conjunction with a drug house. I've never been in that position.

Question: How do you feel about professional jealousy on the part of private practitioners in the community? Do you think that university information officers should put out a press release quoting the faculty member's position on a subject in the private practitioner's area? Do you find this a problem?

Answer: I happen to be very fortunate to be in a city where there's virtually no town and gown problem, which tends to be true of older

universities that were there before the doctors were. In newer universities, there are major problems of this sort. I know that the local physicians and specialists in a community have a certain degree of hostility toward the university having a public relations office and putting out information. I don't know of any easy solution to that problem, other than having the doctors work together or having the PR office work with the practitioners as well as the faculty members.

Question: Do you consider it important to educate the public?

Answer: I think public education is important and I think we need to communicate with the public. There are physicians who really don't believe in this. I have had older physicians criticize me for telling a patient the diagnosis; I just don't think that you can deceive patients. I don't think that's ethical. But yes, there is a difference in philosophy. I think to some extent that part of public education is using the media to educate patients, and I think that we ought to do it. And we will be criticized.

Question: A trend that has been identified is the increasing role that private industry will have in funding universities and scientific research. I am wondering what sort of ethical guidelines exist to protect the public interest and also individual scientists and institutions from charges of biased research, for example, if you have doctors who are doing studies on birth control pills or tampons, and their research has been supported by the company manufacturing these products.

Answer: I think many of us intentionally avoid funding from places like the American tobacco industry for obvious reasons. Even if you're working on something that isn't that directly related to a company, at least among one's colleagues there's a certain amount of skepticism about your work. There was an article in Science about Friedman's recommendations about the National Science Foundation and closing down the National Institutes of Health and going back to the old days when the great private philanthropists funded all research in the country. I can see some terrible problems if we do that. There have been comments made questioning why public funds should be spent on drug development when in fact the drug companies will end up making the profits, theoretically. There are diseases with too few victims to justify developing drugs, from the drug company's point of view. The drug company knows the market is not big enough and it simply will not work on them. This goes for very rare diseases such as Wilson's disease, for which there is a very effective medicine and for which the entire market in the country is about 10,000 patients. Now, no drug company is going to further develop drugs for a disease like that; it's very hard to get one company to even continue manufacturing a drug for that disease. Potentially the situation could be such that it's tough luck if your disease isn't common enough to be marketable.

Question: How would you rate the progress of medical news in terms of responsible reporting?

Answer: It's better. It's not good yet. About 1957, I met a science writer for The New York Times and he said that at that time The New York Times and The Wall Street Journal were the only two papers in which you worked your way up to being a science writer. In a midwestern city where I later lived I got to know a science writer on one of the newspapers. He was a very good and knowledgeable reporter who had been in the newspaper business a long time. But he had been sports editor and had had a heart attack. Therefore, he was disabled and couldn't really make it to the games. So they assigned him to cover science. He preferred sports, but he covered science. On the other newspaper there was a young woman who was hoping she could work her way up to the society page by starting out on science. It used to be that science reporting was not very interesting and exciting and consisted of tiny items on the back page. Science is now on the front page and receives more coverage, yet it still has not developed enough prestige within the hierarchy of newspapers. There are not many newspapers even now, I believe, that have science editors.

Comment by member of the audience: That's right. Out of the 1,750 daily newspapers in the United States, the number of newspapers with reporters assigned to science has declined. And those newspapers that have people who used to cover science are now covering environment. They don't do science anymore.

Question: I agree that the scientist must determine whether the reporter has done his or her homework. But what do you do when obviously the reporter doesn't have the time or the inclination to do that homework? Do you decline an interview with that person? And are you accused of favoritism after that?

Answer: When I met with the reporter who didn't want to read anything in advance I really didn't have much time. I saw her for 15 minutes, and it was obvious she didn't understand very much about what had gone on. I handed her the things that I had suggested she read beforehand. She wrote a piece based on those articles--well, it was plagiarism, but an accurate article.

Comment: Our problem is that general assignment TV reporters cover our science stories and they don't have the time or the background to really understand what's going on. But they have to get the story and they want film on it.

Answer: I don't think any local television channels have people with science backgrounds unless there is one in New York. They send whoever is available. If Action Camera is covering a fire in our area and they want to pick up a medical story on the way, it's the reporter who covers the fires that comes by. No, I suppose you can't expect science know-how from them. They're not really writing a piece; they're usually doing a short spot and ask only about four questions.

Question: Is there any effort being made in places such as medical schools to help scientists learn to speak intelligently and coherently about their work? This is also a problem.

Answer: I think there would be some value to that effort. You're not going to get scientists to come to a course on how to talk to the media. A writer married to one of our faculty members did give a course on communication last year focusing on how to best present papers at meetings. She invited anyone interested to a series of talks, some of which involved how to communicate in a more general way. Much to my surprise, the room was packed. But the offer was put into the context of presenting papers to other scientists, which really is the same problem. Many of us talk to people working in the same area who have a great deal of background and who know everything you've done up until today. They want to hear only what's new. The next day we may talk at a county medical society meeting to people who have to be approached at a totally different level. In that respect, it is important for physicians to learn to change the way they talk, depending upon their audience, so they are not talking up to or down to scientists, fellow physicians, patients, or the media.

APPLIED SCIENCES: ENGINEERING, AGRICULTURE, AND COMPUTERS

Dr. William P. Flatt
Dean and Coordinator
College of Agriculture
University of Georgia

What do applied science researchers see as major impediments to wider dissemination of our work in the media? The first obstacle is the timidity of the research scientist and the fear of ridicule--not only by his or her peers, but by others as well. Scientists are concerned with being misquoted in the media and having their peers read the exaggerations, distortions, and errors that might appear. Sometimes the headlines are the offenders rather than the articles themselves.

Another fear is ridicule by the general public when it learns of the research being conducted. All of us in agricultural research do some work that has a very serious base, but that can be made to appear ridiculous or trivial if it's explained in only a few seconds or minutes on television or in a newspaper headline and brief article. So there's concern about ridicule by the media and the general public, as well as by politicians such as Senator William Proxmire.

It is no small matter to receive a Golden Fleece Award. We're all aware that the reputations of some scientists have suffered as a result of receiving one of these awards from Senator Proxmire. One scientist took his case all the way to the Supreme Court and won. The research in question was on chimpanzees gritting their teeth. As a result of the court case, Senator Proxmire not only had to pay damages, but also had to apologize to the scientist from the floor of the Senate. Being subjected to this kind of attention does affect a scientist's willingness to share his or her work with the general public.

Another obstacle is that many scientists fail to appreciate the importance of informing the general public about their work. Even in land-grant colleges we sometimes live in an ivory tower. Some scientists feel that they have no responsibility to inform the general public. They know in their minds that they're doing significant work, so they don't understand the need to tell others about it.

Failure to communicate effectively is another major impediment to wider dissemination of information to the media. An example is the scientist who went into a drug store and asked for some sodium salicylate. The pharmacist said, "You mean aspirin?" The scientist replied, "Yeah. I never could think of that word!" Scientists are often unable to communicate effectively because they have a tendency to use jargon, and that jargon is different from one discipline to the next. Even within agriculture, scientists in agronomy sometimes can't understand what the agricultural engineers are saying, or they have difficulty understanding the social science terminology of agricultural economics. I'm sure the problems become even worse when you cut across colleges.

Another impediment to the dissemination of scientific information is that many people in the media don't know enough about agricultural research to decide what's exciting or important, and too often scientists assume they do.

Another problem is that each research project is only one small part of a big puzzle or a big picture, and scientists can lose their credibility if they claim too much for their research. In the agricultural experiment stations, each time we prepare to report research using the Current Research Information System (CRIS), we project the outcome of the research. Most of this research is mission-oriented, which means we're aiming at a specific goal. But there is always the possibility of overstating the case and losing credibility.

Public exposure may, in some cases, make it more difficult to actually get research done, so some scientists prefer not to discuss their work. They are well aware that their research is quite sensitive and could lead to a negative reaction by people who would prefer that this type of work not be done. This might be true in engineering, as well as in agriculture and some of the other sciences.

In scientific communication we must also consider the problem of timing. For example, a lot of research is long term in nature. Some studies in breeding and genetics look pedestrian and seem to move very slowly. Even though they are extremely important, many of the long-term breeding projects in plant and animal genetics may not seem timely or newsworthy, so they often don't meet the criteria for media coverage. On the other hand, premature release of information can be damaging. This concerns many scientists. They find that some of the really innovative farmers or agribusiness people--those who are really ready to adopt new information--are quite likely to use strictly preliminary data from the first or second year of a project. When Jimmy Carter was governor of Georgia he wondered why scientists at the University of Georgia had to repeat the same projects three to five years before releasing information on them. In fact, caution in releasing information may help to keep some farmers from going out of business because they might otherwise adopt the wrong technology. We have several examples of varieties that have not made the grade, or various cultural practices that we thought would solve problems but proved ineffective with later testing. Premature release of information can damage the credibility of the scientist as well as actually cause economic losses to the people who use (or misuse) the information.

Some research in agriculture may have been considered a little too delicate or sensitive in the past to share with the general public. But considering the nature of some of today's television programming, I don't think it's the problem that it was at one time. Yet there are certain subjects some people still think shouldn't be aired.

We ran into this problem recently when our board of regents was developing a plan for a television series to show the outstanding research accomplishments in the schools of medicine, agriculture, and engineering. One area I wanted to discuss was our work on soybeans, which are important

for good quality protein. But explaining the work would involve discussing the research being done to control insects, diseases, and weeds, and the use of chemicals in this area was a sensitive subject. At the present time there is considerable public concern about pesticides. Much of it is well founded, but some of it is misguided and unnecessary. The fact that we have a fair amount of research aimed at reducing the use of agricultural chemicals has great economic and environmental significance. But because some people frown upon the use of pesticides, it's difficult for the public information people to cover this work without using some of the sensitive words.

It has become virtually an obligation to disseminate information about the importance of agriculture. As Dr. Jean Mayer has indicated, at the turn of this century we will be producing nearly twice as much food, but another 2.3 billion people will have to be fed, and at present there are already many hungry people. We've heard about this situation so much that it has lost its newsworthiness, and people don't pay much attention to it. But the problem is going to become real as a result of the population explosion and the fact that so far we're not able to increase food production at a high enough rate. The need for food is basic to everyone's life, and we have a responsibility to focus public attention on research in this area.

In addition, many people are unaware of the handsome dividends that investment in ag research pays. There are plenty of cost/benefit analyses that have been carried out to show the importance of the new technology that has developed in agricultural research. Many studies have shown that there's a 30 to 50 percent return per year on the funds that have been invested in agricultural research and education. As a result of the basic research in engineering, the transistor has been used over and over to benefit mankind. There are many examples of this sort. Research that has results you can show, tell, feel, smell, or count is something that the general public can understand and visualize better than some of the more esoteric types of research.

In spite of the special problems involved in communicating science, there are several ways to improve communication between researchers and the public.

First, public information officers must maintain a sense of the importance of the job they do. It's important to the general public. It's important to your employing institution if it is going to continue to be able to get tax support--and all institutions do receive tax support. It's important to scientists that their work be recognized in a meaningful way so that people understand the significance of it. Also, indirectly, it's important in enabling scientists to continue to get the kind of support they need.

Credibility is absolutely essential. We cannot take the chance of releasing information that would damage credibility. As you know, interpretation of data does change from time to time, even with the same basic facts. But it's extremely important to protect and develop a sense

of credibility. This credibility has to be with the media, the scientists themselves, the administrators of the institution, and the public. These groups may not be ready to believe you to begin with, but you must work hard to establish credibility.

Another way to improve communication is to learn to speak the language of all the people you are dealing with. This is easier said than done. It's extremely difficult to know the jargon and to speak the language of the general public, the legislators, and others. Of course, the general public and legislators have basically the same language. Your job is to translate scientific information into language that's understandable from one group to the other. Doing this requires a number of things. It takes involvement, getting in and talking to reporters. It takes great intelligence. I can't imagine a more difficult job, and I've been pleased with the kind of work I've seen. It takes concern and sensitivity to translate scientific jargon into something that can be easily understood by the general public.

After collecting and translating data, you must condense it if it's going to get used by the media. You have to listen and to hear; you have to identify with the general public, with citizens, scientists, administrators, and journalists. You must also keep up to date on the activities at your institution. To do an effective job, to take advantage of timely events, you must not only keep up with research but also teaching, news reporting, public opinion, readership, and audience trends.

It's also important to be loyal to the institution you're serving. You're representing the university to the general public, and this is difficult to do unless you are loyal and have commitment to the institution. If there are problems you should take a positive approach: help identify campus problems and help solve them.

Another suggestion is to take advantage of opportunities. The eruptions of Mount St. Helens probably provided a real opportunity to call public attention to the research being done on volcanoes. Scientists throughout the United States became involved in this news story, and the general public came to understand it. One news release explained that the eruptions may not have been all bad--that they may speed up formation of soil and that top soil could be generated more rapidly. Releases also focused attention on air pollution and related difficulties, such as acid rain.

Opportunities to communicate science do come along, even though sometimes they come in the form of disasters. An example was the mycotoxin outbreak in the Southeast. With a severe drought, worm infestation, and difficult climatic conditions, we had a very difficult time with mycotoxins. We had requested appropriations to get additional funds to study this because we anticipated it would be a problem in the future. But our requests had been turned down. The problem actually occurred, and some dairy farmers were not allowed to sell their milk in North Carolina. As a result, the problem got publicized, and the governor provided funds to build the mycotoxin laboratory we had been requesting. The General Assembly provided funds to continue research on the problem.

So, as far as our farmers were concerned, here was a disaster that became an opportunity to publicize the needs of agricultural research.

Drought is another example. As a result of the drought in 1980 we will probably have less difficulty when we go to the legislature for funds to do irrigation research.

Inflation is on everyone's mind, and this makes it easier for us to tell the story that increased efficiency of processing and marketing and improved technology can help reduce inflation. Current interest in energy is another example of an opportunity for communicators. Agriculture is a source of renewable resources. We can produce soybean oil and peanut oil to be burned in diesel engines. We can make gasohol. But we're going to need public awareness that it takes an investment in research to produce such alternative energy forms.

Another example of a problem that became an advantage was a television newscaster's report on the poisonous aspects of 2-4D. It showed a man wearing a mask spraying a plant inside a greenhouse. One of our scientists saw this and realized that the report couldn't possibly be accurate or the spray would have killed everything in the greenhouse. Rather than just sitting there he picked up the telephone and called the television station. The newscaster said he wanted to know more. He came to the university, filmed some work with the scientist, learned more about the subject, and did a television series pointing out many different aspects of the research being carried on. As a result, we were able to reach hundreds of thousands of people.

We've produced an advertisement showing how agriculture is attempting to address timely concerns. For example, everyone is concerned about food production, about having a plentiful supply of food that's economical, nutritious, and safe. Our advertisement includes slides that explain the research being carried out in food production at agricultural experiment stations, as well as research in the marine sciences conducted under the Sea Grant Program. The turf in one of the slides was developed by a Georgia USDA scientist, Glenn Burton. It was one of his failures--it didn't grow rapidly. So instead of grazing cattle on it, he used it to develop many of the turfs used on football fields, golf courses, and lawns.

The advertisement also points out that engineering is related to peanut production. When former President Carter got out of the Navy in 1954, the average peanut production per acre was 605 pounds. It was about 1,000 pounds for several years following that. At the time he was elected President it was over 3,000 pounds per acre. He realized this increase was due to the application of science to insect, disease, and weed control, and to the development of improved varieties.

To illustrate the agricultural engineering aspect of research, the advertisement includes slides showing a spray to control insects, diseases, and weeds. They show Dr. Ed Law, a good spokesman for science, who developed a little spray nozzle that directs the pesticide spray to all

sides of a plant, rather than just to the front side of it. Use of the nozzle can reduce by half the amount of pesticides or agricultural chemicals sprayed. In fact, some studies indicate that the amount used can be reduced to 1/4, 1/6, or even 1/7 and still achieve control. Field studies have clearly indicated that the damage to insects on fields sprayed with half the amount of chemicals is every bit as good as or better than the damage to those sprayed with the usual amount.

Another aspect shown in the slides is engineering involvement in water management. Irrigation is coming into the Southeast more than it has in the past, and we have a large underground water supply that we must learn to control. Engineers trained in engineering colleges are responsible for helping to lead multidisciplinary efforts to study water management.

We have another excellent spokesman, Dr. Dale Threadgill, featured in the slides. Georgia is the poultry state, and Dr. Threadgill is the engineer working with poultry industry personnel. Instead of having them manually move chickens, the engineer developed a scheme in which the chickens are guided over to a belt, ride up into the truck, and are transported away--without ever being touched.

The slides emphasize solar energy research by showing how energy is used to help heat a pig manure pit so that methane production is more rapid. One of our scientists won a Golden Fleece Award for his research on jogging pigs. The award did not stop his work because he knew that it was important to find the most effective way to raise pigs--to find out what effect exercise has on the pregnant pig and the size of her litter.

Georgia is known as the peach state, but there have been some problems growing peaches because many mature peach trees have been dying. One of our scientists thinks he may have circumvented this problem by planting rooted cuttings. Our slides show the peaches he obtained from 14-month-old bushes instead of three-to-five-year-old trees.

There are numerous other examples showing how agricultural research leads to improvements in food production and other areas. There are many opportunities for public information officers to help the public understand and appreciate university research. This work is important to future generations because many of today's efforts are looking ahead. It's the kind of work that will affect generations yet unborn.

Question: What do your research administrators do to help your communications people?

Answer: First, we place some emphasis on communicating. We encourage our scientists to discuss things with our science writers. Also, we do have a mechanism by which our science writers can be aware of what projects are started. Each time a project is initiated a copy of the proposal is sent to our department of agricultural communications so that our communicators can know what is being done.

We also encourage the actual investigative process. For example, the first thing our recently appointed ag communications department head did

was to go to the departments, get acquainted with the scientists, and talk with the department heads. So when representatives from an Atlanta television station came to campus to do a story with one of our scientists who was talking about soybean cyst nematodes, right away the communications head told the reporter, "They're little worms in the ground," and pulled one up to show the reporter. He helped to translate the story as a result of his first-hand knowledge of the subject.

We also have an annual report that is handled through our ag communications department. Each department is asked to send examples of the 10 most important projects in the department for the fiscal year. Then, our ag communications people determine which examples to include in the annual report.

In agriculture we have the Current Research Information System (CRIS), which provides print-outs of every project funded with federal, state, or private funds. Also, each time an article is submitted to a journal, an information copy is sent to the ag communications department.

Question: Does your institution also do basic research?

Answer: Yes. Although my topic is applied sciences, we identify 36 percent of our research activity as basic, and we feel that we can definitely defend it. In fact, the general public, media, and legislators are interested in such things as photosynthesis, nitrogen fixation, and interactions of trace minerals. We have one scientist who's internationally known for his research on zinc metabolism, and yet we know of no case during his entire career where there's been a zinc deficiency in our state. But we can point out the knowledge he has and the things he's learned about interactions and homeostatic mechanisms of minerals. Some day we're going to run into problems with trace minerals and, if we know the answers in advance, we'll be better able to face those problems.

We can also point to basic research by one of our plant geneticists 10 years before we had the outbreak of southern corn blight. When it hit, it was devastating. But we already had a scientist who had done research in this area and had shown that Texas male-sterile cytoplasm corn was susceptible to the microorganisms that cause southern corn blight. There was already enough information, plus the research done in other states, to combat this problem. Between 1962 and 1971 we had to defend the scientist's work. Once the problem arose, however, he was the expert. He was the spokesman speaking to civic clubs, to farmers, and to legislators, explaining to them the research he had done.

We have a lot of good examples of basic research. I wouldn't have any problem selling at least half of our program as basic research and saying that, if it weren't for basic research, we wouldn't have the applied science providing advancements for the future.

JOURNALISM, THE ACADEMY, AND THE NEW CLASS

Dr. Michael Novak
Resident Scholar
American Enterprise Institute

A basic change in social structure has occurred in the United States since World War II. In 1939, there were 900,000 undergraduates in our colleges and universities. And from about 1947 until 1967 we built a new college campus, on average, every two weeks. In the state of New York the campuses mushroomed, as they did in most other states. Now there are about 13 million persons, mostly between the ages of 18 and 22, enrolled in universities, colleges, adjunct institutions, commercial schools, and others involved in professional/vocational preparation.

The number of faculty was about 60,000 in the 1930s. It's now well over 600,000, and more when you count the assistants in the laboratories, libraries, and elsewhere. If ever we formed a union, it would be larger than that of the steel or mine workers.

Since 1945, then, we have tremendously expanded our elite in terms of education. At present about 13 percent of the adult population has at least four years of college. On the principle that a little knowledge is a dangerous thing, our educated class is particularly vulnerable to a shifting conventional wisdom. When a new idea comes along, educated persons are more likely to learn of it and take it seriously; five years later they may decide it was all a fad and mostly mistaken. You might change all the childrearing practices of an elite group of Americans and 10 years later these people might be reacting against those practices, saying they were wrong and they should never have followed them. It's too late for the children. There are great advantages to higher education, but education alone does not guarantee wisdom.

The expansion of our elite in terms of education is real. Probably many of us are the first persons in our families to get a college education. That's true of many Americans.

There has also been an expansion of the elite in terms of income. The average income of a surgeon or lawyer in 1939 was $4,500 and $4,100, respectively. Today 20 percent of the population by household has an income of over $29,000. (That figure now jumps by about $2,000 a year because of inflation.) That's a tremendous amount of discretionary income, of which never in history have so many people had so much. On the other hand, it makes you wonder what the 80 percent below that income level do. How do they send three or four children through college, and how do they provide for medical care and other basic necessities?

Besides education and income, there is a third index: status. According to the Census Bureau, in 1970, 23 percent of American workers were professionals or managers. A very large part of this group consists of high school teachers, owners of some kinds of small businesses, and members of

new professions that hardly existed in 1939, such as psychiatric social workers, science reporters, football players, stock brokers, and so on. The significant social fact is that such persons are paid on an annual basis: weekly, bi-weekly, or monthly, not by the hour. They may work 80-hour weeks, but they work at their discretion.

Thus, when you are organizing a political campaign, the people you turn to are the managers and professionals; if they take off a day or two, they don't suffer any salary loss. The workers who punch a clock can't do that. They have to work eight hours a day and, therefore, may be able to give you only their evenings. One must use a very different organizational principle with one group than with the other. That's in part what is meant by "the new politics"--the availability of millions of professionals and managers across America for political activism, activists with new skills concerning words, symbols, and organization who can completely outflank the old political machines.

Teachers, as the New Republic has reported, are now the single most significant lobby in Washington, more powerful than the oil companies. With a windfall profits tax, you can take $200 billion from the oil companies in a matter of six weeks in Washington. The teachers are very highly organized in every town, village, and precinct of America. They know people. They are professional and skillful. A powerful political force.

The first point, then, is that the elite--defined by education, income and status--has expanded tremendously.

The second is that the elite has also split. At least half of the members of our highly-educated, highly-paid, high-status group find that our interests are better served through an expanding state. The more the state spends and the more the state does, the more opportunities there are for us and our students. This is the first time that the American elite has been divided in this way. It used to be said that the business of America is business. Now the business of at least half of us is making life difficult for business. And we see that our own income and career opportunities and those of our students depend very heavily on growing federal spending. It is not so likely that the National Education Association will come out for less government spending in education. So we're seeing in our midst an interesting class struggle develop concerning two ideas about the shape of America--whether it will have an increasingly large state-funded sector or a private sector increasing the scope of its activities and powers. That's a fascinating issue, but I don't propose now to go any farther down that long road, except to add that the war of ideas is highly significant.

The next point concerns the meaning of news in this environment. One of the interesting things in learning to write for newspapers in particular, and to some extent for television, is that not everything that is true is news. There is a very important difference between what is true and what is news. There are certain things that are absolutely true that are boring, however relevant they may be. They don't sound right when you're reading chiefly for what's new.

There is a particular problem with the news that we haven't faced adequately enough. The reason is due, I think, to that change in social structure I described. Not very long ago, intellectuals and university professionals looked down with some disdain upon the news. They never expected that what was important to the world could be communicated through the news. One used to speak with glib contempt of Time, Newsweek, and The New York Times. It simply never occurred to serious people that you would read those publications to find out what was important in terms of ideas, science, and social science. In those days, such publications aimed at a common denominator and relatively low level of understanding. You simply didn't look there for serious information. And in fact, were you to write for or to appear in such publications, your career would suffer. One of the reasons that attitude has been transformed, of course, is the expanding education both of the readership and the writers. Almost all persons who now work through the media or for the media have at least four years of college education. Almost all have incomes of at least $29,000 a year. Almost all are professionals, if not managers. If you remember, by contrast, in the movies from the 1930s, the correspondents and the journalists used to be working stiffs identified with the proletariat. Indeed, at that time, intellectuals and university professors were pictured as absent-minded professors, not terribly effective or important in the world. Today, the persons who prepare and write the news, and develop and create the symbols and images through which we understand ourselves as a people, are increasingly coming from the top 20 percent of the population. Moreover, they tend to have taken predominantly one side in the war of ideas between classes within the elite itself.

The largest story of our time on which all other stories hang is the story of change. For the last 40 years, change predominantly meant larger government. An American sermon must always end with a recommendation of something effective to do, like starting a committee. You can't leave an American audience with an image of human evil in the world. In America you must always end a talk with a positive recommendation of something to do, and if you don't, your audience will resist. When we find such recommendations in our news stories, the implication is often that government should do something. It is assumed that the principal agent of change is the government. That accounts for the fact that most of the news on the front pages of newspapers and most of our leading stories on television are about government. They are much less often about industry, universities, or science. One is struck by this fact on visiting Eastern Europe, where so much of the news is about the introduction of a new tractor outside of Leningrad, or some new machinery in Bratislava. The evening news on Soviet or Eastern European television is much more focused on the world of work and on technological breakthroughs. What we mean by "news" here, one notes, is dramatically different.

Again, news about religion has long been rather badly handled in America. The average comprehension that sophisticated people have about religion is poor. How can you be 40 years old in America and not know what a "born-again" Christian is? Not long ago, it was easy. When Jimmy Carter

came onto the scene in 1976, many major reporters went scurrying around trying to find out, "What's an Evangelical?" And that's the largest single body of believers or ideological group in America. It's a group with a certain image of the world, a certain sensibility about the nation, and probably the one closest to the origin and meaning of this country. So much of our imagery of the New World, of the new beginning, of the capacity to start over, of a New Deal, centers around the experience of being "born again." Every political campaign needs its slogan, and you always have half of it before you begin. You know it has to connote a "new" something, and you debate what the next word should be. This impulse comes less from the Puritans with their sense of depravity and sin than from the Evangelicals with their sense of being born again. It's a side of the American tradition that is very important. Until recently, hardly anyone ever paid much attention to the Evangelicals. Yet they are numerous and have in recent years become wealthy, well educated, and powerful.

Thus, in talking about the meaning of the news, we are led to the problem of the structure of the news. Today, we have national news media. In the 1930s, Henry Luce invented a paper of a quality that would reproduce color and photographs with high fidelity. And then he developed an ink that would dry instantaneously. Once those were achieved it became possible for a national news magazine to be put to bed editorially on Friday night, printed Saturday, and without waiting three or four days for the ink to dry, stapled and mailed and in people's hands by Tuesday morning. Suddenly you had available a means of communication with the elite throughout the nation. Time and Newsweek boast that 23 million Americans a week read them, which is about 10 percent of the population. Their audience coincides rather well, I think, with that elite I've been describing. Now, almost simultaneously, the newspapers have developed a focus, too. The reports in The New York Times on the national and international news appear not only in New York but in newspapers across the land. They are syndicated. When you read news stories in Topeka, or Portland, or wherever in America, you find that you are reading The New York Times, The Los Angeles Times, The Washington Post, AP, or UPI.

This structure has a bottleneck. The number of persons concerned with science, or universities, or ideas, who have input into the newspapers of America is very small. They probably number not more than several thousand. That is extremely important to keep in mind. When we talk about the news on a national level, we're talking about a finite number of editors, writers, and favorite sources. We're also talking about a finite number of available column inches. A few media--AP, UPI, The Los Angeles Times, The Washington Post, and The New York Times--are the chief guardians of those inches on the national scene.

Something similar has been true of television. There are 70 major media markets in television. In those 70 major markets, there are, for the most part, three channels available--fewer in some areas and more in others. (Cable television is revolutionizing this structure.) So multiply 70 times three. Now how many science or idea reporters work at each of those channels? Not more than one or two. So again, you're dealing with a universe of maybe 500 people across the country who have

influence on the content of television, and not all of those have access to national television. If you're thinking simply of national access, the number is, of course, far fewer. There are the three networks and public television, and there are just a handful of science or idea reporters. That makes the problem rather different than it would be with greater numbers.

I would define the problem as a form of surprisingly common world outlook--Solzhenitsyn has reported his astonishment at the extent to which our media present the same view of reality on almost everything. There is no significant ideological difference between ABC, CBS, and NBC. And it would be hard to pick an argument between Time and Newsweek in terms of ideas, on what they accept as true, or on what they argue for. The interesting thing about human life is that when people sit down together, they disagree not so much about the facts. Rather, they look at the world so differently that they can hardly tolerate one another. If you observe an argument between liberals and conservatives in our society, it seems, at times, as if they live on a different planet. We live in very different worlds in America--regarding abortion, the Equal Rights Amendment, government spending, welfare, crime, almost any symbolic issue.

What's interesting about our national media is how they finesse that problem by taking a view of what seems plausible, which becomes the conventional wisdom and is acceptable to at least a majority of those in the top 20 percent. This is the audience they basically reach on current events shows such as "Meet the Press"--about 10 million people. The media are able to shape a conventional wisdom that is largely accepted by educators and other sophisticated people across the country.

We've learned to live with this sort of public world and we know there is no use arguing with it, even if we privately disagree. There are certain things that people take as plausible and they negotiate from there. You realize if you step outside the conventional wisdom that you are in for an argument, and you may not feel up to an argument right now. We find at cocktail parties or evenings of relaxation with friends that as the conversation gets spirited and wanders away from the conventional wisdom, and as people begin saying what they really think, friendships sometimes fall out. And people say, "If I had known they thought like that, I would have never had anything to do with them!" Through these sorts of pressures, Americans, ironically, are becoming more and more birds of a feather. We are now free to choose our neighbors. In times of relaxation we associate with people with whom we basically agree. The only time in America where people still sit down in a systematic way with those whose politics they can't stand, or whose religious ideas they abhor, or whose general views of the world are in complete conflict with theirs is at Christmas or Thanksgiving with their families. The only melting pot left in America may be at the family dinner table.

Another important factor is the indispensable preeminence of print in the world of ideas, science, the humanities, and other fields. True, we have hardly explored the capacities of television and film for communi-

cating many ideas that are important. I don't want to underestimate the possibilities of television or film. Still, in recent years I've been struck by the extent to which there are so many things that can't be said, so many distinctions that can't be made, except in words. They can't be explained on film or on television. They really have to be expressed in cold print. For example, it's interesting to follow what a politician says on television and to read it in cold print. These are two very different experiences. One allows you a certain coolness in judging the content of the idea and the other involves your human reactions to the presence of the person. You find that the radiance of eyes or skin, the inflection of the voice, and other signs may communicate something at variance with the words. My mother pointed out to me that every time a certain presidential candidate talked about love, she thought he was accusing her and trying to make her feel guilty. The words were saying one thing, but the intensity and the severity of the voice were saying something else. As we gain more experience living in the world of television--we're the first generation to do so--we realize how untrustworthy television is in the field of ideas. In at least some senses, we were much more coldly informed about politics when we knew what was going on in a campaign only through reading newspapers, when we couldn't see the images and couldn't be involved in that personal reaction. Ideas mattered more.

There is also a structure in the social sciences and the humanities of which we must be more aware. There is an intellectual structure below the surface, but influential in the way ideas are addressed. There is a growing gap, I think, between that top 20 percent of the population and the other 80 percent. The people of the United States, for one thing, are far more religious in many ways than the elite tends to be. The elite, even when it is religious, tends not to say so. Some things are not often shared outside the privacy of the heart. This almost systematic etiquette may separate the elite from others. This seems to be happening in religious matters, in moral matters, and in attitudes toward life as a whole. These differences show up in many opinion surveys.

The humanities also have a peculiar bias against a whole aspect of modernity that is hard to bring to the surface. Humanists, writers, poets, and philosophers were once supported by the nobility, and their destiny was linked very closely to that of the aristocratic class. There were lovely salons, beautiful palaces, great paintings, and other works of art commissioned by the aristocracy. This was a happy marriage--an aristocracy of money and title wedded to an aristocracy of intellect and talent. And the imagery of the aristocracy fit very neatly with the self-image of artists. Interestingly enough, the intellectuals and the artists were almost never aristocrats. They were almost always bourgeoisie--people who were not quite serfs and not quite nobility, who had the talent, who created the works that aristocrats would pay for. Beautiful salons were not made by aristocrats; they were actually built by bourgeosis craftsmen. But the imagery of the bourgeoisie fell short of the class of the nobility. The humanities have always been identified with the upper class. To say "a prince of a man" is to make an aesthetic statement, but also a class statement. To say that someone has an

aristocratic taste is a rather nice thing. To say that someone has bourgeois taste is not intended to be so nice.

Perhaps I can sharpen this point by saying that it suddenly occurred to me one day what we in the liberal arts are liberated from. It hit me with the force of a single word: "work." The liberal arts are non-industrial, non-servile, non-commercial arts. And there is built into that tradition a suspicion of anybody who sweats too much. It has been said that the entire history of English literature is Luddite and anti-machine. The history of the sensibility opposed to capitalism, industry, and commerce is apparent, from "the dark satanic mills" of William Blake to the scenes in Charles Dickens's novels. There has hardly been a friendly voice for commercial civilization and industrial civilization; almost all literature was hostile.

Part of this, I think, is because in the humanities there is a deep sense that the better you are, the fewer the people who can really appreciate what you do. If you can make all the fine distinctions necessary for true understanding, only a certain group of people can appreciate your achievement. If you are reaching a mass audience, something must be wrong. There is a conflict between the humanities and market principles, which cuts across the relationship between many experts in the humanities and the journalists. It's a deep, emotional conflict. When humanists think they are doing what they ought to do, they tend to think of themselves in rarified ways. The market principle seems wrong to them. If something is reaching a mass of people, it must be on a low level of discrimination; it's not likely to be very good. There is a tone of voice in which people speak of journalists as mere journalists.

There is a similar problem in the structure of the social sciences, born in the same moment as socialism, which understood itself to be the science of social behavior. The assumption was that society can be taken apart, analyzed, and presumably made to work better by experts who can put it together better. There is remarkable suspicion of the market principle and an antagonism toward the irrational behavior of individuals who are likely to do what they damn well please, rather than what they know is good for them at any given moment. And there is also a potent conflict in the way one simply looks at the world, in the almost unconscious expectations of the world, as between the viewpoint of the social sciences and that of common people.

Yet the viewpoints that naturally receive greatest and most potent play in our media tend to be those of the most articulate, most highly educated, most acculturated to the rules and the sematics of the conventional wisdom. This is understandable. Yet isn't it worth worrying about the danger that a rather large elite--some 20 million--may go on talking to itself, not quite in touch with the perceptions of the other 200 million?

We need to take special care about our democracy, given the new structures of a society so dependent upon the media. It is a hopeful sign that many persons, from many directions, are attending to such issues.

COPING WITH CONTROVERSIAL RESEARCH

Dr. Robert DuPont
Clinical Professor of Psychiatry
Georgetown University
School of Medicine

I have had a lot of experience with the media, not all of it positive. I am one of the few people in this room today, I would suppose, who has had Jack Anderson devote several columns to saying unflattering things about me. I even had a local television investigative reporter spend full-time for a year covering me, going through my wastepaper baskets and talking to everybody I had ever fired or otherwise had anything to do with. So I have a personal insight into some of the risks in dealing with the media and some of the pain that goes with it. I went to a play last night by Bertolt Brecht called "Galileo" and wrote down a couple of quotes that I thought would set the stage for what we are talking about. At one point, Galileo says, "As much truth gets through as we push through." I thought that was an interesting concept--the idea that we have to push to help the truth. At another point he said, "Won't the truth just take care of itself? No, it requires some assistance in terms of getting the truth across." He also said, "It is such bliss to doubt."

In communicating about science, it is particularly painful to the public to see the extent to which scientists find such bliss in doubt. Reporters find this bliss even more difficult to deal with. My own experience with reporters, especially communicating controversial subjects, has been in three areas. One is in the drug abuse area, where I spent many years treating heroin addicts and in which the primary controversy had to do with the use of methadone, an addicting narcotic drug that was perceived at times as a panacea for heroin addicts and at other times as a curse--a case in which, as some people say, the cure was worse than the disease. It certainly was an enormously controversial subject. I have also spent a lot of time working on the marijuana issue. I am now the president of the American Council on Marijuana and have spent a good bit of time, in the last three years in particular, on marijuana research. The third area, which is newer to me, is related to my work with phobias, such as public attitudes toward nuclear power, the Three Mile Island accident, and other issues related to nuclear energy and public reactions to that. I had the unique experience of watching for 13 hours over the course of two days all the network news coverage of nuclear energy for the last decade. Some of you may know that Vanderbilt University has taped all evening television news shows since 1968 and has now cataloged them for researchers to use; they are available by subject, by reporter, by network, or any other kind of indexing. The collection is a marvelous resource for research. As I watched these newscasts, I found the dominant theme, particularly in recent years, has been the theme of fear. Fear literally overshadowed any technological, scientific, or economic considerations. I think even a casual look at the nuclear issue would reveal that it largely hinges on fear. So my background in dealing with controversial research is in the areas of heroin/methadone, marijuana, and fears, especially fears of nuclear power.

Part of the problem that most university researchers have in communicating controversial research is their own fearfulness in dealing with the reporter. Who is this person? Researchers want to know something about the reporter; they want some reassurances. They are also concerned about being quoted accurately and having their information presented in an accurate and full fashion. I encourage university researchers or those who work with university research to try to put in perspective what the interaction is between the reporter and the scientist. Essentially, the reporter's job is to write the story or to put it on the air. The researcher has to deal with the fact that he or she has absolutely no control over that story--that it is somebody else's job and not the researcher's. He or she is not responsible for the story and cannot control it. No matter how careful the researcher is, how many times he or she qualifies things, how many times he or she goes back over things, there's nothing a researcher can do to control what that reporter is going to say. As Harry Truman said, "Don't go near the kitchen if you can't stand the heat." If you cannot accept the fact that it is not you writing the story, but the reporter, then you should not be talking to the reporter. The reporter will decide what to include and will relay it to the audience in any way that that reporter sees fit. It is the reporter's responsibility and proper role to do that. One of the problems is that the research, particularly in controversial areas, does not always get presented as fully as one would like, or always in the context that one would like. All these problems can be understood as part of the problem of understanding roles. The role of the reporter is to report. The scientist can and should explain his or her findings and views fully, but he or she should also respect the limits of his or her role. The scientist does not control the story. The reporter and his or her bosses do.

Also, and I guess this goes back to our scientific preoccupation with Galileo and a few others like him, the researcher would like to be a hero. One would like to be seen as doing a very good thing. Being criticized is probably the most painful outcome, even more painful than being misquoted, of this interaction between a researcher and a reporter. It is painful to have the reporter go out and find somebody who says, "I know that jerk and he has published that junk for the last three years, and it doesn't make any sense at all." But this is the way that the media work. Essentially, they are concerned with what they call "balance." Once an issue is defined as controversial, the media, although they are interested in the truth and the facts, will have an even greater commitment to balance. If you are saying that marijuana is a bad thing, then they have got to find somebody who says it is not so bad, or it is good. If you are trying to discourage people from using marijuana, it drives you crazy to have them do that. I know this firsthand! The same thing is true with the nuclear energy issue. If I say that fear is an important issue and that it is separate from the concern about nuclear technology, then the reporter is duty-bound to find somebody who says that you have good reason to be afraid. And it is even worse when you know that statement is going into the same story that has your statement. You have to be prepared to deal with that, and you must realize that you probably won't come off as the hero you know you are!

Another concern is that of being misquoted. Again, I think the issue has to do with recognizing the limits of one's control. Perspective can make all the difference. A couple of years ago a reporter for The Atlanta Constitution came to a talk I was giving about marijuana. He asked me what my primary concern was. And I said my primary concern was people, especially young people, who were using a great deal of marijuana. By that, I meant using it every day or several times a day and that this was happening at a very high rate. As some of you may know, one in nine high school seniors smokes marijuana every day, averaging three-and-a-half joints a day. To me this is an enormous percentage of very heavy use of marijuana. I said that is what I was most concerned about. So the headline the next morning on the front page of The Atlanta Constitution was, "Federal Official Unconcerned About Casual Marijuana Use." In a certain sense there was something to that, but it was just a little bit off of what I had in mind! The reporter was quite pro-pot and said so in the discussion with me and with others. After a protest to the editors, they did run another story that was more accurate. They never did take back the first story, but they ran another story on page three about my concerns. That reporter no longer works for The Atlanta Constitution. It may also be a long time before I get invited back to Atlanta to speak on marijuana.

Another example of controversial research is the so-called Rand Study of Alcoholism. Essentially the study found that relatively high percentages of people who were treated for alcoholism and defined as alcoholics by the criteria used in the study were at a later point found to be drinking in a way that would be defined as social drinking. So the headline was, "Former Alcoholics Can Become Social Drinkers." That produced a storm of protest from the alcoholism community, Alcoholics Anonymous, and the National Council on Alcoholism. It became a cause celebre and a test when anyone would speak about alcohol. "Where do you stand on the Rand Study?" (You had to go one way or the other.) "Can the former alcoholic ever become a social drinker?" This issue raised a question that is also raised in many other areas--the larger implications of some research findings. They may have an important truth in a particular context, but used in another way can have an alarming negative effect. Most of us who have worked with alcoholics shudder at the idea of an alcoholic resuming drinking because so often we see the pattern of the person saying, "You know, I haven't had a drink for several years, I'm going to return to social drinking, and I can do it." And that leads to disasterous consequences for the individual and for the family. The implication of this study was clinically scary for people working in the field. And I think that kind of sensitivity to broader implications of research is important for both scientists and reporters to have.

Research as it relates to social policy usually becomes controversial. There is a lot of public interest in policy issues. It is rare to find a research study that is directly on target to the social policy question being dealt with. Usually it is related, but in some kind of controlled or limited fashion. The question usually becomes, "Can this research be extrapolated? Can this be applied to the larger policy issue?" One of the things I have found interesting and painful is the

realization of how limited our research endeavors actually are in terms of their capacity to deal with important policy problems. Many of the most vital problems of the day are not the subjects of research.

An example that I was involved with was the heroin epidemic in the late 1960s. What happened to make that epidemic occur? What was associated with the decline of the epidemic and is now associated with the relative rise, at least in some parts of the country? There has been almost no research done on that subject, although there have been a few papers written on it. But it remains a mystery which gets little research attention. For reasons I do not fully understand, it has not been interesting to our colleagues in the research community. I do know that researchers, if they are to succeed, must limit their focus and conduct "do-able" studies that will produce quick payoffs in terms of publication. That means ignoring big, often important, issues because of limits of time, money, and technology.

Another problem we have in communicating research is that on controversial subjects "the experts don't agree." Former Senator Edmund Muskie a few years ago said he was looking for a one-armed scientist. The reason was that all scientists said, "on the one hand this," and "on the other hand that." Muskie felt if he could only find a one-armed scientist he might be able to get a straight answer to his questions. The fact is that people involved in public policy dealing with controversial issues do want to find answers. I think we often underestimate the extent to which there is high motivation not only to find answers, but to use them. The problem is that in most of these areas the experts do not agree.

In nuclear power, for example, you can find plenty of experts on both sides who have fine credentials. You can find plenty of people in the scientific community who think marijuana is a terrible drug and is destroying our society. You can find an almost equal number who think it is relatively benign. Methadone is another example of the same kind of disagreement. Researchers need to recognize that they are entering a different arena when they enter public debate and that they will be disagreed with. They will not be perceived as having all the answers, as a sort of white knight charging in to solve the problem. We must recognize that researchers are people who have feelings, too. I think often both they and the people who relate to them tend to forget this. It is important to recognize that it is fun, especially in dealing with controversial subjects, to get some attention focused on your work for your university, for yourself, and for your subject matter. The glare of those bright lights is addicting; people like it, and they like the excitement--at least some people do. I am reminded of Andy Warhol's dream of having a democratic system so that everybody can be famous for 15 minutes. If only we could have that, we would solve a lot of our problems!

It is fun to get involved with reporters and controversial issues, if you are in a proper frame of mind. The proper frame of mind means that you understand that you are not charging in with the answer, that the water is not going to part before you, and that everyone is not going to say,

"Great. Now I understand what the problem is with inflation. Professor Jones, you have the answer." You have to recognize that plenty of people are going to criticize you. And the more notoriety you get, the more recognition you get, the more people are going to criticize you. When I was feeling particularly picked on by Jack Anderson a couple of years ago, my brother, who is a university researcher, said he thought it was an honor that I was the only person in the family who ever had Jack Anderson work him over. That, he felt, was quite an achievement. It was helpful to me to have him say that because I was feeling a little unhappy about what was happening. The one nice thing for researchers dealing with controversial subjects today compared to times past is that people no longer burn you at the stake; they just misquote you and criticize you.

Question: Is public fear of nuclear power phobic? If so, has that fear been created by media reporting or are the media simply responding to a widespread phobia that pre-existed?

Answer: Much of the public fear of nuclear power is phobic and much of it is, if not created by, at least encouraged by the media. But not all fear of nuclear power is phobic, and not all of it is caused by the media. By phobic fear, I mean essentially thinking that focuses on what could happen as opposed to what is happening or what has happened. This is absolutely characteristic of somebody who is phobic. A phobic person is rarely concerned about right now; he or she is concerned about what could happen. "The airplane could crash." "I could lose control on the beltway." Whatever the issue is, it's almost invariably future thinking. Phobic thinking is insulated from the experience itself. Even though the person has done this many times and never panicked, or lost control, or the plane has not crashed, the experience gets insulated and reinforced by the concept that it could happen and there's nobody who can say it could not ever happen. That is characteristic of what happens in the concern about nuclear power. Three Mile Island is the classic example of a "what if" problem. The Presidential Commission on Three Mile Island concluded that there was no health damage whatsoever associated with that accident for the workers in the plant or for the public at large. They calculated, in fact, that perhaps the radiation release associated with that accident would produce seven tenths of one death increase over the lifetime of the 50 million people living within 200 miles of TMI in the context of 350,000 expected cancer deaths in that population. That was the conclusion of what actually happened. Now when it comes to what could happen, that Commission report was in no way a whitewash of the Three Mile Island accident. It was hostile to the industry and to the operators of Three Mile Island. There was plenty of what could have happened in that report. But what concerned me about the media reports was that there was almost no reporting of what did happen in terms of the health effects and there was a tremendous preoccupation with what could have happened, with "how close we came to a disaster." The commercial nuclear power industry has been around for 25 years and has been widespread for 10. It seems to me that at some point the media have a responsibility to talk about, not what could have happened, or what might happen tomorrow, but what has happened in the last 10 years. What has

the safety record been? The one negative health effect the Presidential Commission did identify was that the people in the area were fearful. I went up there and talked to many of them, and they were. Now the media are drawn to the issue of fear because the media's aim is to get attention. One of the things that will definitely get people's attention is fear. If you can report in a weather forecast that you have a storm closing in on the area, people are going to listen to the weather. The same is true with the news. I do not blame the media for this; it just has to be accepted. The public is getting much better educated about controversial issues and is learning a terribly hard lesson. The lesson is that we have to be able to make decisions in an information environment in which the experts do not agree when there is controversy. It is hard for most people because even if we are experts, we are experts only in one or two areas. We do not have broad expertise in all areas that affect our lives. It's difficult for the public to learn to live with the idea that in important issues there is disagreement and uncertainty, but even so, we must make a decision and move forward.

Question: I'm interested in seeing how universities cooperate with the media in educating the public better. I want to ask you about courses by newspaper that attempt to build instructional situations around a series of articles. Does that really work?

Answer: Among the payoffs, it seems to me, is to help people think about the media as sources of knowledge, of learning, of education; and that is a very important concept. The amount of good information available through the media is overwhelming. Media people are, of course, preoccupied with being embarrassed by being criticized for doing something wrong, for getting the facts wrong, or for whatever else. The reality is, at least from my point of view, that the amount of balance and wisdom and information that gets put across in all the media is just incredible. Two years ago I had a contract with "Good Morning, America" on ABC-TV to comment on mental health subjects. I have only two issues that I can talk about as an expert--drugs and phobias--, so I needed new material for my regular appearance on the show. The best sources were the women's magazines--Redbook, Family Circle, Ladies Home Journal, you name it. Those magazines are full of the most incredible information about human relationships, anything to do with the family, with sexuality, with work, with whatever really involves people. People may think, "Oh, it is just junk." I found they were good articles; they were solid; they were well researched; they gave a balanced view of what was going on; and they were helpful. It was impressive. I did not find one article that I felt was really trash among the nonfiction articles. Those editors were putting out useful information on important topics, at least it seemed to me. Some of my best ideas came from those magazines!

Question: You mentioned the fear that scientists and others have of the media. Have you studied at all the impact on these people of their encounters with the media?

Answer: Often university researchers are terribly frightened of media exposure and back away, which I think is unfortunate. On the other hand,

some researchers hunger for it. They come back again and again and they like the exposure. Others go away feeling bruised and battered by the experience. They tell their colleagues about the awful experience of being criticized and misquoted. At least, I hear many of my scientific colleagues say they are not well served by the media. The problem is rooted in their misunderstanding of their role in relationship to the media. It has to do with the fact that the researchers think they are more important than the reporter does. It also has to do with the grandiosity that gets built into going after the truth. They see the reporter as a vehicle to simply put across their message, and that is not what the reporter does. The researchers can publish their articles in Science or Nature or wherever, and that is fine. They are then the writer; it is their byline; and they are responsible for what is there. If the reporter writes it, it is the reporter's story and he or she is responsible for it. A lot of people in the university community feel that they have a lot to say and they feel that they are ignored, that people are not interested enough in them. When they do get attention, they feel they do not get their full view across, or it is not quite what they had in mind. Whenever you get criticized or have your facts reported inaccurately, you must realize how few people will see the article anyway. If more researchers could have this perspective, it would help. Recently I was on the "Today" show for half an hour. The "Today" show does not often have half-hour segments. How many people in this audience saw that? No one! That is typical. This is the kind of experience that instills humility. It was a big thing to me to do that show, and yet the reality is that less than four percent of Americans saw the "Today" show that day. And I'll bet less than four percent of those who did see it can remember it two weeks later.

Question: How do you feel about public information officers who inform reporters that there is a controversy on a scientific subject when the reporter did not know it existed in the first place?

Answer: The best articles that I have been involved in were not my ideas, but were the reporter's ideas. When a reporter comes to you with an idea, he or she will fight to the death to get that idea across. If it is the other way around, the reporter often feels you are putting something over on him or her. I think the most important way of working with the media is to be on their side in some way. You have got to respond to their needs. When they come up with an idea, you have got to help shape it in some way that makes sense. So the most important thing in dealing with the media is to have their confidence. Part of doing that is letting them know what is going on. If your job was to get one story across in the most favorable way, then I would not tell a reporter about a controversy. If you do not tell a reporter about the controversy, he or she may think your researcher is the cat's pajamas and that is the end of it. The story just runs like that. But in the long run, what is really important is that the reporter knows that he or she can come to you and that you are going to watch out for him or her. As I said before, reporters have their anxieties, and they want somebody they can count on. So if you alert them to a controversy, they are going to be, at least from my experience, responsive. On the other side of that, if they find out that

you withheld information that was important, they are going to think about you in a slightly different way the next time.

Question: Wouldn't it be difficult to convince the faculty of your institution that that's a good attitude?

Answer: Yes, because they have more limited exposure to the reporters and they never see the followup. You should communicate to them that this is part of a relationship that extends over time and that they are part of that relationship, too, and are benefiting from it, even if it is only for one story. There must be a relationship of trust and mutual interest. Obviously, the reporter needs it, too. The reporter has to fill that space every day. Not only that, but the reporter has to compete with the other reporters for space because they are all coming in with stories. If the reporter does not get a story on the front page or on the evening news for many days, he or she is off the paper or off the air. So the reporter has to make it a good story. He or she has a natural community of interest with you. If the reporter is going to spend time to even talk to you on the phone, let alone send a crew out to do the story, he or she has invested in that effort and wants to get it on the air. So you work with the reporter on how you can do that. You respond, for example, by providing sources. We have had a fair amount of publicity about the phobia program I am involved with in Washington, and almost all of it has been generated by the media. For example, there was an article in The Washington Post last fall about voting phobia. It never occurred to me that one of the reasons people do not go to the polls is that they are afraid to walk into those booths. But the reporter who wrote the story was sensitive to the issues of phobia partly because this reporter is a former phobic herself. So she knew that was an issue, and she called up and asked us about this idea. She wanted to talk to some phobic people about their voting experiences. Our job was simply to put the reporter in touch, not with scientific experts, but with phobic people to find out what happens to them when they get in the voting booth or think about going to the voting booth. People may have seen that article and may have thought it was the work of a good PR department. We did nothing except respond to that reporter's request to get in touch with some phobic people, and we did it quickly. We did not say, "Come back next week." We said we would do it immediately because that is the way reporters work. Again, I think the problem is that most people worry too much about negative press. If you can get across the idea that criticism is part of the cost of doing business, that you are not always going to be a hero, that there is always going to be some criticism, and that it is an inevitable part of relating to the press--then I think everybody is going to be a lot better served. It is just not all going to come out positive. The first time I ever got criticized by the press I really felt bad. I would drive to work and listen to nonstop radio news about what a terrible person I was. Every night I came home and it would be on the television. At one point it was even the subject of a prime time documentary on one station. I went to a friend one day and said, "This is a terrible thing. Not only that, but I really am a good guy; I am not really a bad guy." He said to me, "Well, I'll tell you what. If you want to play it fair, every time you get a good article or

somebody says something nice about you and you know you didn't really do what they're attributing to you, or you really aren't the hero they're implying you are, you should go to the paper and say you're really not as great as they made you out to be. Then it's fair for you to complain about negative press. But unless you're prepared to give up all those favorable pieces, then you're just going to have to take your lumps." It was very helpful advice for me to think about it that way--that criticism is just a cost of doing business. Everybody does not understand that.

Question: How did you deal with the privacy issue in disclosing the names of those patients?

Answer: It was easy. First of all, we have some patients whom we know don't have a problem talking to reporters. In all cases, however, we just have the patients call the reporter. We call the patients, give them the reporter's name, and tell them if they want to talk about this, fine. In phobia work there is a real sense of missionary zeal on the part of some recovered phobics about helping other phobic people. Others would not touch the media with a 10-foot pole, and we certainly do not put any pressure on them to do so. We have had no negative effects from the patients who have revealed themselves on television or radio about their phobias. On the other hand, we respect the feelings of the patients who do not want to share their experience publicly.

Question: Our institution developed a technique and the scientific apparatus for this technique. Two major publications did a feature on this technique and the apparatus and just totally overlooked us. They didn't even give us a paragraph or a sentence. Obviously, our faculty and departments were shocked. What do we do about this? Do we write a letter to the editor? Do we visit these people to set them straight? Do we get on the phone? How do we handle this kind of a situation?

Answer: I would tell both publications, for one thing, exactly how you feel about it. I would make sure that they at least know about it. But again, I would say this is the way the cookie crumbles. You just have to talk with the people at your institution. You can go to the reporters and explain the situation. Sometimes they will, like The Atlanta Constitution, come back and run another article. I would be forceful and direct, but also respectful and tolerant. I think we need to remember that the reporter has the responsibility for the story and not the researcher or scientist. The researcher or the university PR office is not responsible for what the reporter is doing. The researcher is responsible only for presenting his or her ideas as well as possible. After that, it is up to the reporter. If the reporter's story displeases the researcher, then I think I would put a little salve on the wounds, sort of like my friend who took me aside and said you win a few and you lose a few. Otherwise, you cannot play the game. If you have to hit a home run every time you step up to the plate, you are not going to play baseball. Remind the offended researcher how many times he or she has gotten sole or primary credit for work that was done by many people, and how many times your institution has been falsely credited in the media--not always having

fully deserved the praise. It's harder to remember these positive experiences, but I'll bet they are more frequent than the more easily remembered negative experiences.

MAKING THE ARCANE PLAIN

Dr. Lynn Arthur Steen
Professor of Mathematics
St. Olaf College

I am a mathematician by trade, not a journalist. Since for most people mathematics is the archetype of an arcane subject, I can speak with some authority about arcane matters. But I don't know if anyone can make the arcane plain.

In alchemy, the arcane represented a profound secret of nature. Indeed, in this age, most profound secrets of nature are expressed in mathematical terms. Because the alchemists always associated great mystery with the arcane, it soon came to symbolize as well as an elixir, a type of marvelous remedy. The same thing has happened in this age: Many scientists, especially social scientists, find that the best remedy for an ailing theory is a mysterious dose of numbers and statistics; it gives soft science what one mathematician described as "mystification, intimidation, and an impression of precision and profundity." Mathematics is the elixir of the scientific age.

I use the word mathematics, or the phrase mathematical science, to include any of the quantitative and theoretical disciplines, such as statistics, computing, operations research, systems theory, theoretical physics, or mathematical economics, in addition, of course, to the traditional core of mathematics as defined by the school subject of that name. In calling all these things mathematics I do not intend any type of intellectual imperialism; it is merely a shorthand way of identifying what they all have in common, and what makes them arcane.

IMPEDIMENTS TO PUBLIC UNDERSTANDING

Despite the significance and prominence of the mathematical sciences in our technological society, it is nearly impossible for anyone to describe for a lay public the content or implications of research in these fields. The distance between the research frontier and public understanding is probably greater in mathematics than in any other field of human endeavor. In virtually all other areas of science, the general public is aware in a rudimentary fashion of major 20th century contributions. Most people have at least a vague understanding of electrons, DNA, black holes, genetic engineering, and microprocessors, even though they neither understand nor care to understand such things in detail.

In contrast, public vocabulary concerning mathematics is quite primitive. Except perhaps for some pejorative feeling about "sets," most people's closest contact with mathematics has been an (often despised) high school course in Euclidean geometry. General understanding of mathematics is not a decade, not a century, but a millenium out of date. Explaining

what is actually happening in contemporary mathematical science to the average layperson is like explaining artificial satellites to a citizen of the Roman Empire who believed that the earth was flat.

Not only is the public's mathematical vocabulary archaic, but public interest in the issues of central concern to the mathematical sciences is virtually nonexistent. Effective articles (or TV programs) must be about subjects that really interest people. People may be seduced into learning the rudiments of biology because of their intrinsic interest in medicine, or the rudiments of chemistry because of their interest in environmental problems. But there are no alluring roads to mathematics.

Finally, public understanding of mathematics is impeded by a public attitude that is an anomalous mixture of awe and contempt. Although the average citizen speaks in wondering tones about his "genius" nephew who scored 800 on his mathematical aptitude test, he appears proud of his own ignorance of things mathematical: "I never did understand percentages." Even well-educated people who wouldn't dare admit in public that they have never heard of Keynesian economics will brag about their lack of understanding of statistics or calculus. By and large, non-mathematicians do not value mathematical knowledge enough to regret their ignorance of it.

WHAT IS MATHEMATICS?

Before discussing further the difficulties associated with translating mathematical research into common language, let's look at the nature and scope of contemporary mathematics.

Carl Sagan, talking in Cosmos about the young Kepler's fascination with the order of the universe, stressed Kepler's belief that geometry was the language of God. Indeed, Kepler seemed to believe that geometry was God. For contrast, to see how far we have progressed since Copernicus, Kepler, and Newton used mathematics to establish a new scientific paradigm, consider George Burns, playing God in the movie, "Oh God, Book II." He says, "Mathematics was one of my mistakes."

The reality is somewhere in between. Mathematics is a diverse and almost incoherent collection of pure and applied disciplines united only by a special focus on abstract structure. Much of the recent growth of these mathematical sciences was due to the extraordinary scientific research effort of World War II. Other parts of current mathematics research have roots that go well back into the last century. Here is a sample of what is now included in mathematical science:

1. Statistics, the theoretical basis for medical research, environmental studies, and political polls.

2. Mathematical logic, the theoretical basis of computer science, as well as the foundation of mathematical truth.

3. Operations research, the application of mathematical techniques to problems of industrial and economic optimization.

4. Group theory, the abstract representation of symmetry, now used to model the structure of crystals and to organize the fundamental constituents of matter.

5. Computer science, the study of programming languages and data structures that make our modern age work.

6. Graph theory, the representation of relationships required for computer design, information networks, and transportation systems.

7. Topology, the abstract study of form, now used to explore the geometry of the universe, the evolution of living things, and the dynamics of the economy.

8. Theory of algorithms, the modern way to solve problems through step-by-step procedures that computers can follow.

The point of this list is that mathematics today is more than just algebra, calculus, and Euclidean geometry. Mathematics is a vast, sprawling complex of subjects united more by research methodology than by common content. Although its influence on society is frequently hidden from public view, mathematics has shaped our world in fundamental ways, and continues to exert profound yet indirect influence in every aspect of our daily lives. Despite all this, the public remains fundamentally illiterate in all things mathematical.

LITERACY IN MATHEMATICS

In a 1975 article in the American Scientist, the astronomer Benjamin Shen distinguished three aspects of literacy in science--practical, civic, and cultural. Practical literacy is knowledge that can be put to immediate use in improving basic living standards. The ability to compare loans, to figure unit prices, to manipulate household measurements, and to estimate the effects of various rates of inflation brings immediate and real benefit. Popular demand for texts in "Arithmetic for College Students," evidence from the National Assessment of Educational Progress, and the recent popularity of mathematics "clinics" designed to cure the fad disease of mathophobia or math avoidance corroborate the enormous extent of practical mathematical illiteracy.

Civic literacy involves more sophisticated concepts, namely those that would enhance public understanding of legislative issues. Major public debates on energy, environment, and the economy frequently center on scientific issues. The inferences drawn from the data, the projections concerning future behavior, and the interaction among variables in a complex system involve issues with essentially mathematical content. A public

afraid of or unable to reason with figures is unable to discriminate between rational and reckless claims in the technological arena.

The third in Shen's levels of scientific literacy is cultural--the attempt to communicate about science or mathematics as a major human achievement. Because cultural literacy lacks an immediate, practical purpose, its appeal will be limited largely to a subset of the intellectual community. When one considers that the readership of the cultural monthlies like Harpers, Atlantic, and Scientific American is about one-half of one percent of the U.S. population, a cultural approach to mathematical literacy will hardly contribute to general "public" understanding of esoteric research. Yet, to be honest, this is the only level on which the arcane and esoteric can really be appreciated--as a contribution to the heritage of human culture.

MATHEMATICIANS VS. REPORTERS

There are two basic factors that inhibit reporting about mathematics research: mathematicians and reporters. Without them, there would be no problems at all.

Efforts at public understanding of mathematics are often frustrated by mathematical scientists' concerns that talking about mathematics is not an appropriate or adequate substitute for doing mathematics. Those who hold this view argue that simplification for public consumption necessarily entails oversimplification, and that oversimplified mathematics--lacking precise definitions, hypotheses, and deductions--is no mathematics at all. Since logical precision and not experimental observation is the essence of mathematical reasoning, proper understanding requires the distinctive flavor of precision rather than the hash of incomplete description.

The weight of this argument is formidable. In practice, it has meant that mathematics is virtually the only major scientific discipline that lacks an expository forum for communication with the nonspecialist. No one but an expert can read any of the publications that discuss current mathematical activity. It has certainly contributed to the impression--widespread among journalists and scientists who have tried to examine mathematics--that mathematicians are haughty and uninterested in relating to ordinary mortals. When was the last time that anyone from a university department of mathematics or computer science called a press conference to discuss his or her latest discovery? A well-known mathematician at the Courant Institute in New York was quoted in Science several years ago as saying that he was not interested in fame, fortune, or public acclaim, but wanted only "the grudging admiration of a few colleagues." Even in collegiate education, texts for those courses whose central purpose is mathematics literacy (that is, survey courses for liberal arts students) focus on elementary and hackneyed topics where the precision of definition, theorem, and proof may be understood and practiced rather than on a survey of the current major problems and research frontiers.

Whether intended or not, the effect of this insistence on doing mathematics in order to learn about it is to erect insurmountable barriers to persons who have other primary interests. Critics call this arrogance; mathematicians call it scholarship. It is one of the major hurdles that any science journalist faces when trying to cover the mathematical sciences.

The other major problem in covering technical, quantitative stories is that few science writers know enough about the mathematical sciences to do stories in this area. Many of the best science writers have no mathematical training beyond high school and thus suffer from the same illiteracy as the public for whom they are writing. Of course, a good writer may convert this illiteracy from a handicap to a benefit, since it makes him or her more able to empathize with the difficulties the reader will face in reading about mathematics. But to do this the writer must at least know enough to ask the right questions and demand clear answers.

Two recent examples show that this minimum requirement of competent journalism is not always present. The report of the Task Force on the Public's Right to Information of the President's Commission on the Accident at Three Mile Island said bluntly that many reporters were illiterate when it came to radiation matters: "They did not know what questions to ask." As a result, "radiation coverage at TMI was abysmally inadequate. To a reader or a viewer trying to decide whether to pack his bags and run, radiation reports in the media were often as useless as a baseball score of 6-4 that neglected to mention which teams had played." The report concluded that the fault lay partly with sources who failed to provide complete information, but also with reporters who "confused matters with improper comparisons, insufficient background information, and factually impossible statements."

The reporting at Three Mile Island was done under extreme circumstances, and it is understandable that even the best efforts might have produced confusion in that story. But last year similar confusion, with much less excuse, permeated press coverage of the new algorithm for linear programming discovered by the Russian computer scientist Leonid Khachian. Following rather routine initial reports in Science News and Science, The New York Times picked up the story under the flamboyant headline:

A Soviet Discovery Rocks World of Mathematics.

It wasn't primarily the headline that bothered researchers, but blatant errors in the story on which the headline was based: The Times claimed for Khachian's algorithm powers that it did not have, powers that no Russian or American scientist claimed it had. The Times error was caused by inattention to the subtle distinction between two problems that sound rather similar: In fact, one could be solved, the other could not be.

The crowning blow, however, came after months of correspondence between the Times and various computer scientists and mathematicians involved with this work. The Times printed a lengthy clarification, under the headline:

A Russian's Solution in Math Questioned:
Americans who Studied
Khachian Linear Programming Method
Express Doubt on its Scope.

It was as if somehow either the Russian or the American scientists were now revising their original claims. The opening paragraph, coyly cast in passive to avoid the need for an actor in this drama, continued the misrepresentation:

> American mathematicians who have studied the new Soviet method for solving a difficult class of computational problems known as linear programming problems say that the feat announced last November, while important, is far from the seminal achievement originally portrayed.

Few readers would infer from this that it was the Times itself that painted the original, distorted portrait. For many mathematicians and computer scientists, however, these events reconfirmed their worst fears of press distortion and misunderstanding.

SUGGESTIONS AND RECOMMENDATIONS

The portrait I have painted of the arcane disciplines seems to leave little hope for making them plain. Disinterest of the public, mathophobia of reporters, and disdain of researchers form an unpromising basis for effective communications.

There is, however, some evidence of opportunity that could lead to interesting, innovative reporting in the future. The abiding interest in Martin Gardner's column in Scientific American, the unprecedented excitement about Douglas Hofstadter's Godel, Escher, Bach, as well as continuing public interest in mathematics education (new math, back to basics, computers in the classroom) provide touchstones for penetrating the facade of public disinterest. Mathematicians become what they are because of the intrinsic power of mathematics to pique the imagination and compel attention. Even for those who turned away from mathematics at an early age, some of this original spark remains and can be fanned into luminosity by approaches such as those of Gardner and Hofstadter.

Mathematics, too, is changing. Not only is the subject itself beginning to touch on matters closer to human scale--cost-benefit studies are a bit easier to comprehend and interpret than is the fluid dynamics of thermonuclear plasma--, but mathematical leaders are becoming aware of the need to meet the real world half-way. The new publication called The Mathematical Intelligencer contains news and information of interest to a broad public, although it still requires a college mathematics major to read most of it. A recent self-study by the Mathematical Association of America included among its resolutions one that called for greater efforts to inform the news media of matters of interest to the general

public arising from within the mathematical sciences. That resolution may amount to not much more than good intentions, but even that is an improvement over the past.

Whether a change is occurring in science journalism I cannot say. I do note a distressing lack of coverage of the technical, quantitative sciences in the several new popular science magazines. Indeed, I've heard that this is generally a matter of editorial policy--to stay as far away from mathematics as possible. I would suggest, however, that this may not represent a good reading of public interest. There is a large and increasing number of computer hobbyists (represented by the subscribers to magazines such as Byte), amateur mathematicians (represented by Martin Gardner's fans), and statistically-oriented scientists. These individuals would generally appreciate simple explanations of the quantitative reasoning and evidence behind many of the science stories now reported without any significant or reasonable mathematical background. How is it, for instance, that a poll of only 950 individuals in a state as large as Illinois can be accurate, as pollsters claim, to within 3 percentage points? Or, what statistical inferences support the various FDA decisions to remove carcinogens from the public market? A sizable minority of Americans can appreciate the significance of questions such as these and can understand a clear explanation that does not duck basic mathematical issues.

To present science without mathematics is to present results without reasoning, conclusions without evidence. Doing this fails to communicate the natural symbiosis between the scientific method and mathematical modelling and distorts in the public mind the nature of scientific inquiry. The task of the science journalist in covering the arcane subjects of mathematics, statistics, and computing is not just to seek out stories within those fields, but to constantly show how methods from the mathematical sciences make possible the results of the natural and behavioral sciences. Doing this will both improve science journalism and increase public understanding of the role played by the quantitative, theoretical, arcane disciplines.

TRANSLATING THE CURIOUS LANGUAGES OF RESEARCH

Jon Franklin
Science Writer
The Baltimore Evening Sun

In his book, Lives of a Cell, Louis Thomas makes a basic point that language does more than just represent culture. In many senses, it is culture. The problems of the science writer stem from the fact that his or her source belongs to one culture, the scientific one, and the reader belongs to a vastly different culture. That cultural gap is critical to any discussion of the use of language to bridge the gap.

My favorite cultural gap story involves the discovery of the pulsar back in the 1950s. A pulsar is a spinning cinder from an exploded star, but in the 1950s that wasn't known. However, in hindsight, astronomers had the formulas to predict that there should be such a thing, and that it should spin very rapidly and spit out a beam of radio waves that would sweep the universe. It would be like a radio lighthouse in space--blinking, blinking, blinking.

At the time, astronomers down in the Carribean, where the discovery was made, were just scanning the heavens. They were involved in a mapping program using a big radio disc nuzzled in the tropical hills at Aricebo. As the astronomers listened to the static from space, they happened upon a strange and intriguing sound. It went beep, beep, beep, beep, beep. The discovery, whatever it signified, was important, and the astronomers knew it.

After just a few weeks of listening to the beeps the astronomers sat down and decided, being good scientists and open ones, that they should announce the discovery to the world, but they weren't sure how to go about doing it. Finally one of them suggested that they tell the editor of the largest newspaper in the United States about it. Then their duty to the public would be pretty much done. It sounded logical enough at the time, so the astronomers sent someone to the library to look up the name and telephone number of the country's most widely circulated newspaper. That newspaper turned out not to be in New York, as they had assumed it would be, but in a place called Lantana, Florida.

An editor in Lantana picked up a ringing telephone. He listened to the scientist, and as he listened his eyebrows went up. Yes, he was interested. The editor scribbled notes. A reporter was on the next plane south. The astronomers were very cordial. They met the reporter at the airport and took him to their laboratories. They told him about this mystery object sitting out there beeping at them. They let the reporter listen to the tape-recorded beeps and they explained their theories. The reporter asked, "Well, you don't really know for sure what is doing the beeping, right?" "No, of course not," the scientists answered.

They freely admitted, as good scientists do, that theories are sometimes in error. What they really knew for sure was that something was beeping.

Then the reporter said, "It could be intelligent life trying to signal us, even."

"Sure," the scientists said, pleased that the reporter was beginning to grasp the basic vagueness of experimental knowledge. Then they started explaining their theories again, but the reporter was in a big rush to go. They escorted him back to the airport, saw him off, and forgot the matter. Later they discovered that he represented a scandal sheet that focuses on cancer cures and the tribulations of the widow Onassis.

And so it was that the most important astronomical observation of the decade was announced on the front page of the National Enquirer. The banner headline said in 72-point type something like: "Space Beings Contact Earth." The story, I'm told, ran on the same page as a piece about an arthritis cure and an exposé on Elvis.

The point is that this chasm exists. On the one hand, there are the scientists. Far, far over on the other hand there's everyone else, including the people who go to the supermarket and buy the National Enquirer and thereby get their news about scientific discoveries. Now whenever you find cultural gaps, you find language gaps.

Let's consider why scientists see the universe differently than we do and why they consequently have developed their own language to describe that universe.

Languages are not nearly as arbitrary as the people who write dictionaries would sometimes have us believe. The scientific universe is different from ours. We don't deal with protons, significant statistics, black holes, or mitochondria. Every time a scientist discovers a new thing, he or she has to label that thing in some fashion and that becomes, over a period of time, an important and new word. So scientists are forced to develop their own complex language that is alien to us. This is something that science writers take for granted.

But at the same time we must not forget that the words don't have to be as alien as they are. They are also a barrier. After all, it was just 50 years ago, for instance, that linch mobs hunted for doctors through the streets of Baltimore. The doctors, according to rumors, performed autopsies.

Scientists throughout history have been an extremely embattled group, and they remain that way today. Complex language is one way they can discuss things among themselves without getting in deep trouble with, for instance, the antivivisectionists. So they use the language as a defense mechanism.

As a case in point, one of my favorite little words is data. When I first ran into it, dāta was a group noun, it was pronounced dāta, and you would say that the dāta <u>was</u> ridiculous. The word dāta became a fairly

handy word and went into the English language. Truck drivers started to use it.

Suddenly, the scientists switched. It was no longer dāta. It was now dăta, and it became plural. Now you would say the dăta were ridiculous--and so was anybody who used the word incorrectly. And the latest one is, I understand, that gynecologists now want to rename their profession. They want to be called gynecologists. The point is that scientists give a lot of lip service, particularly recently, to communication with laymen. They talk about the necessity of explaining what they do to laymen, since the scientists are getting public funding for what they do. They give it a lot of lip service, but their instincts and their history are contrary.

It's foolish for a writer to overlook this cultural paranoia or to expect scientists to be particularly grateful when you translate. Sometimes they are, and sometimes they aren't.

Let's look at the other side of it, exemplified by the people who pick up the National Enquirer as they go through the supermarket. Unlike the scientist, the average American's thought process deals with the concrete and the active. He or she thinks in terms of specific things that are happening. The roof leaks; the clothes need washing; interest rates rise; politicians insult his or her intelligence. The average American also thinks in an emotional way. The fact that the roof leaks has an emotional connotation. There's a worry involved. The person who owns the roof has to do something about it. There are also emotional connotations when the clothes need washing or when interest rates rise. When politicians insult his or her intelligence, the average citizen becomes angry and frustrated. Those are emotional and active thoughts, and they are conveyed by the use of active verbs. A good writer writes that way--in active voice.

Over the years, I have come to depend a lot on Paul MacLean's theory of the triune brain. MacLean is a National Institutes of Health senior scientist who has his own laboratory up north in Washington. His basic thesis, which as a writer I find very helpful, is that the human brain has evolved in three specific periods and at three specific levels. (After all, as a writer, you're trying to communicate with someone; you're trying to communicate with what we are discovering is basically a biological computer. And it helps to know how that computer works.)

At the base of the brain is what Paul MacLean calls the lizard brain, which deals mostly with habit. The lizard brain is not drastically different from the kind of brain you find today in a lizard, or the kind of brain that the dinosaur had. No one knows what kind of biological computer language the lizard brain speaks in or processes.

On top of the lizard brain is something called the mammalian brain, which we share with all mammals, and it apparently processes things in terms of emotions. That's the limbic system; that's where we get our feelings from. On top of that, of course, is the cerebral cortex, which

apparently deals in the abstract. The language of the cortex is whatever language you were taught, in our case English.

It is interesting in that light to consider the way your reader is thinking--in the active voice, in terms of process, and with emotional connotations to those thoughts. Scientists tend to think and to communicate quite differently. They're interested not so much in process. When it comes to communicating, they tend to be interested in results. And they talk about things like nitrosamines or carcinogens, for instance. Neutrinos have mass. Statistics are significant. Scientists get grants. This is the kind of thing that grabs scientists.

Well, the difference here is that "are," "have," and "get" are passive verbs, and passive verbs have very little emotional connotation to them. The most significant difference between scientific language and plain English is the question of active/passive. There are a lot of other ones, too; but that seems to be at the root of this cultural difference. Passive verbs don't connote any physical movement. They're vague verbs, and as anyone who's done much writing comes to understand, the verb in the sentence is the most powerful transmitter. It carries the emotion and the image. Everything else in your sentence is pulled along into the mind by that verb, which I've come to think of as a carrier wave, very much like the electronic carrier wave on which you superimpose your message on radio and television.

That being the case, you should be able to simply change everything the scientist said in passive voice to active voice, and you've got it made. But it doesn't work. The sentences become awkward and the active verbs tend to become bureaucratic verbs. They become things like "awarded" or "advised"--those heavy verbs that don't have emotional weight. They're not much better than passive verbs, although I think they are somewhat better. Every writer tries to judge his or her audience by the response he or she gets. I found that when I changed from passive voice to a bureaucratic active voice I got a few more readers. But the readers, as they had been before, tended to be intellectual types. Actually, they tended to be scientists, not the people who would pick up the National Enquirer, not the kind of people that a popular writer is trying to reach.

Several years later, after tinkering around with this and finding out that changing passive to bureaucratic didn't work, I finally started thinking of passive verbs as symptomatic of something else--of the failure to write in the concrete. That's when I began to understand that scientists tend to focus on ideas and results. Your readers aren't trained to do that. They tend to focus on people and action. As a science writer, then, you realize that if you want to catch the reader and pull him or her into your story, you've got to focus not on the idea and not on the result, but on the human beings involved.

As a result of looking at this and some of the other things that have been happening in literature lately, I think increasingly we are going to see literature that focuses on scientists performing this scientific process. Many of us would agree that science in the last 20, 30, or 40

years has had much more impact on our society than politics has, for instance. So I have a feeling that the next group of books of the quality and magnitude of the political novels that have been written will be about scientists instead of politicians.

To come back to the point, the use of concrete language and active verbs has its roots in the kinds of questions you ask the scientist. If you ask, "What have you discovered?", you are going to get one kind of answer. But if you ask what the scientist did, you are going to get a totally different kind of answer.

Many of us are in awe of scientists, and we certainly tend to forget that the scientist is a human being. He or she had a set of background facts and circumstances and actively did something with them. The scientist tinkered with the machine, put together a chemical apparatus, and poured things into that apparatus. He or she watched what was in it bubble, froth, and foam. And the fact that the scientist came up with synthetic urea is not nearly as interesting to your reader, although that is what's important, as the process of producing it. So if you focus on the process in terms of the very specific, the reader can follow step by step what the scientist did as a human being, not as an abstract entity.

Although the reader may not have had a college education and may not know the big words, he or she is usually nonetheless intelligent. (As soon as you start looking down on a reader, you're dead anyway.) Letting the reader understand what the scientist did is an extremely powerful way of getting your message across. Few of us like to be told something, but we all like to understand what happened and come to a valid conclusion on our own. The conclusions we reach on our own imprint themselves in our minds so much more solidly than the facts that someone tells us. That's the way to get to your readers, to keep them involved, and to see that they remember your main point when they've finished the article.

One of the problems with this, of course, is that in the course of an experiment there are numerous things that happen. If you tell everything that happened you end up with an extremely long list, a lot longer than you can put in most news releases, newspapers, or even magazines. Besides that, the list is boring because a lot of the things that happen are repetitious, are beside the main point, or are blind alleys. What you have to do, then, is refine intellectually what the scientist did. You have to pick out the highlights of that experiment or that process by which the scientist made the discovery and focus on those. If you pick the highlights correctly, using two or three of what I call focuses, you will end up explaining most of the peripheral information the reader needs to know as well.

The idea of a focus in active writing is very important. It's something that was described to me when I was in school by a novelist, J. R. Salamanca, who taught creative writing. Think of yourself as a writer, as a moving picture cameraman. If you pan that camera, the pictures you come up with are moving, blurred, and confused. But a professional focuses the camera on one thing until that imprints itself in the viewer's

mind. Then he or she moves the camera and then stops it, moves it, and stops it. Where you stop that camera is what I am calling a focus, and where you move it is a transition. Transitions tend to be passive, and the focuses should be written in active voice.

Writing is certainly difficult to do and no one does it perfectly. None of us wants to look like an idiot, although we do on occasion do that. Once you decide to focus on a chain of events, once you have decided to give the reader the imagery, it's going to be very obvious if you don't understand what you're talking about. If you are just going to tell the reader what to think and if the reader gets confused, he or she will feel, "There's something wrong with me; I'm not bright enough somehow to understand this," even though it's the writer who made the mistake. Once you've decided to demonstrate a set of focuses to the reader, if you fail at that point it's you, the writer, instead of the reader, who looks dumb. It is very difficult to write in active voice because when you do, you as the writer put yourself on the line, and you're never in such danger of looking silly. Looking silly is what writers always fear. So you have to understand that this kind of writing is scary. If you don't really feel that somebody is going to throw an egg at you, you probably didn't do it right. In any event, having the writer look dumb instead of the reader is one step in the right direction. After all, it is the writer's responsibility, not the reader's, to communicate.

By focusing, by picking out significant action by a significant person who then becomes a character in the truest literary sense, you've limited what you need to explain. But you've made it necessary to explain those things very well by eliminating a lot of the tangential material you would have otherwise put in. You have some space flexibility now, and you can devote six, eight, or 10 paragraphs to a single focus.

That kind of writing requires a great deal of efficiency of language. You have to give so much information that's unfamiliar to the reader; it's got to be done in so little space; and it's got to be done in a way that makes sense to the reader. It is not enough to put a fact down and assume the reader is going to remember that fact. You have to put down that fact in a way that helps the reader to remember it. That's why (after this rule about using the active voice, which I think for science writers is the bottom line) it's important to use metaphors that involve your most critical problem and bring forth your most creative techniques.

Most of us know we have to explain and define unfamiliar terms as we go along in our copy. That's correct, and most of the news releases I see coming across my desk do that. But it's correct only as far as it goes. You can't expect the reader to remember definitions throughout the copy, particularly when they're complicated. People are always writing a sentence in which they use a 75-cent word--I guess it's a dollar-and-a-half-word with inflation--followed by a comma, followed by a reasonably straightforward but very unfamiliar explanation followed by a comma. Throughout the rest of the text the writer will use that dollar-and-a-half word with the expectation that the reader understands what it means. But usually

the reader doesn't. You're lucky if the reader understands it two lines down, let alone on the next page. The reader won't remember definitions: They're facts and they're passive.

The reader will remember active images. If you can give your readers an image that will fit in some familiar fashion into their minds, they will remember that image throughout your story. If you're writing about a neutron star and define it as composed of atoms with no electrons and then you go on with your sentence, the next time you say neutron star the reader probably won't have the vaguest idea what you're talking about. The reader will be confused by it and will feel stupid as a result. The reader's tendency will be to lay the story aside and go on to something that's more interesting, maybe on the sports page. But if you use a word or a concept that the reader is familiar with (I often call neutron stars the cinders of burned out stars), the reader will remember it because he or she knows what a cinder is. Then I would try to use the word cinder wherever possible instead of neutron star so that the image stays with the reader.

The critical thing here, of course, is that when you make up a metaphor, it has to apply. One very troublesome metaphor I run into has to do with mitochondria, which are parts of the cell that produce the ATP used as fuel in the metabolic processes of the cell. A long time ago someone said that mitochondria were the power plants of the cell. In a sense, that's right. That's where the cell gets its energy, and energy is power--therefore, the power plant. But as you try to push that metaphor you find that you can't do it. The image becomes very fuzzy because the reader thinks of a power plant as generating electricity. And the process of generating electricity is not in your reader's mind a chemical process at all. Yet you're trying to use this metaphor to tell the reader something about biochemistry. Since a mitochondrian produces ATP, which is chemical energy, as soon as you use that metaphor you're in trouble, and you're going to lose your reader five or six paragraphs down the story.

All you have to do is just make sure the metaphor applies. Mitochondria function, in fact, as the refinery of the cell, if you want to put it that way. The point is that your metaphor has to give the reader an image that will help him or her understand not just the sentence where you use it, but the rest of the copy as well.

As a general rule, I find that a good news story or magazine article uses no more than three major metaphors. Why three? There are so many rules of three in writing, and I don't know why. It may have something to do with Paul MacLean's triune brain theory. Maybe it doesn't, but that's a good way to think about it.

Another rule of three applies to the use of examples. One example is a contention, two examples an argument, and three examples are proof. That's true, always has been, and probably always will be. If you use three bad examples, you've proven a wrong thing, and you're not going to unstick it from the reader's mind.

If your story is active to start with, lucid metaphors will make it and fuzzy ones are going to destroy it. I'll often spend as long as a week tinkering with metaphors. I don't do it sitting in front of the typewriter, but as I'm doing other things--driving somewhere, standing in some interminable line, or listening to some lecture that I really don't want to hear. I just ask myself how I can come up with a metaphor that is somehow familiar to the person who buys the National Enquirer, but is also true.

The other thing to remember about metaphors is that after they have been used a long time they become cliches, and as soon as they become cliches, they totally lose their meaning. A lot of people now refer to mitochondria as the refinery of a cell, and the reader has seen that so many times that it doesn't mean anything to him or her anymore. As soon as your metaphors start looking like cliches, you've got to start all over.

Now we come down to the question of specific words. I will not give you a long list of words to avoid; those things are very available. I do want to recommend a book, The Elements of Style, by William Strunk Jr. and E. B. White. There's a section in the back that talks about an approach to style, and there are about 15 pages in that section that give the most concise statement I have ever seen about what a writer has to do. I heartily recommend it.

When it comes to words, the rule is specificity. My favorite saying on this is from Mark Twain, whom I personally think is the greatest writer in the American language. He said the difference between the right word and the almost right word is the difference between the lightening and the lightening bug. It's true. You've got to find a word that says exactly what you mean, not sort of what you mean, and that says it using common language. I'll mention the lightening bug words you see all the time. They're all bureaucratic words, the ones that the Government Printing Office puts out, or at least used to put out. A book called Gobbledygook Has Got to Go lists pages and pages of words that bureaucrats love to use and that scientists in their clamor to become bureaucrats have adopted. You have to avoid them if you intend to write well. Advise, for instance, is a word for warn. A bureaucratic word, fund, is one of those words. It means to pay for. You can always think of another word instead of fund. Another is presented, for argued.

Remember, your job is to translate. That means when you are translating something you have to say exactly what the person said in the other language. What the person said in the other language, particularly in science, is untranslatable to start with, literally, in the sense that the word used has no valid common English equivalent in this business. That goes against all your journalistic training. But when you consider that your scientist is going to speak in the passive voice, use words the reader doesn't understand, and use them in forms that the reader doesn't understand, if you quote the scientist you're going to be doing all the bad things to your reader that you have tried to avoid everywhere else in your story. So you've got to paraphrase the scientist and minimize the quotes.

When you see a science writer using quotes that are inactive and that have basically bad word construction in them, you're seeing a lazy science writer. It's a cop-out because the writer can always back out and say, "Yeah, but that's what the guy said." That applies to nothing because it's your job to make what the scientist said make sense. A new lightening bug I find scientists using is synfuels, for instance, for raw materials for synthetic fuel. Who knows what synfuels means? If your reader stops and thinks about it, he or she can figure out what it is. The key here is that if the reader stops and thinks about it he or she loses grasp of what was learned 30 seconds before, gets lost, and feels stupid. And anything that makes us feel stupid we obviously want to avoid.

Some words that are the worst offenders have to do with the defensiveness of scientists, and the words tend to be euphemisms. The worst is the use of the word "sacrifice" for "kill," which you see in all kinds of copy. I'm aware that if you change "sacrifice" to "kill" the scientist you're writing about will be up on a chandelier. Writing well means taking heat.

A word about ego--ours, not theirs. In the process of writing about any group of people, we become very closely attached to them. It's difficult to write about someone without empathizing with that person. I've never written about a mass murderer, but I think if I did I would probably come to like him or her. It's just the nature of the business. We've come to like scientists and there are good reasons to like scientists. They're the epitome of some of the finest human qualities. And quite often, we go another step and try to emulate them.

I think writing is as amenable to the scientific method as physics is--some things work and others don't. By experiment, you can find out what does and what doesn't work. If something works, there is a reason, and I think we can discover it. There is also general agreement that scientists are lousy writers; otherwise, they wouldn't need us. Let's not let our desire to emulate them trick us into writing like them. You see an awful lot of that.

My main point is about the concrete and the active. Scientists are abstract, and scientists are passive. The process of translation involves turning that into concrete, specific, and active language. Scientists use technical words to be specific in their language; that's the way it works. In our language, we have got to be equally specific, but we have to be specific using common words. Scientists tend to focus on facts. If we want to communicate to a large audience we have to focus on action, and we have to use action to demonstrate those facts.

What we are getting at is the same. We use action to demonstrate facts and examples to make those facts meaningful. Scientists tend to talk about what they've found. They tend to deal with nouns. We should be looking harder for the "whys," which is where the verbs are.

Communicating University Research: On The Research Beat

INFORMING THE PUBLIC ABOUT RESEARCH: THE MEDIA

David Perlman
Associate Editor and Science Editor
The San Francisco Chronicle

No matter how many reporters tell you that they never listen to a university "flack" or that they don't care about news releases, it isn't true. You are the people we depend on probably more than any other source.

I found in The New York Times a great juxtaposition to open this discussion on informing the public about research. A headline on one side of the page said, "U.S. Report Fears Most Americans Will Become Scientific Illiterates." The article was based on a report called "Science and Engineering Education for the 1980s" prepared by the Education Department of the National Science Foundation. The other side of the page had a story with the headline, "Jersey's Psychic Searches Atlanta for Killer of Children." Obviously the Jersey psychic is a result of the scientific literacy problem that we in the newspaper business face and that you face all the time. Fortunately, the problem is being recognized by television, which is perhaps the strongest medium affecting Americans' information backlog. It's good to know that all three networks now have full-time science people and we don't have to depend only on Jules Bergman's accounts of what the real truth is in space, engineering, airplanes, and so forth.

There are 1,750 daily newspapers in America and damn few science writers. There may be a hundred or so specialized science reporters on newspapers who really cover--try to cover--science, medicine, and technology full time. If you take the 10 or a dozen who are involved in that process at The New York Times and maybe the six or seven at The Los Angeles Times, you find there are about 50 newspapers in the country that really can claim to have full-time science writers. This means, of course, that your responsibility, if you don't know it already, is even greater because so many newspapers rely almost exclusively on the material you put out. We have now, as you all know, an absolute explosion in the science magazine business with Science 81, Discover, and Science Digest. The December issue of Science 80 alone cites the work of 22 American university researchers in various places, plus another half dozen research institutions that are not directly affiliated with universities, hospitals, and the like. As you can see, with the increasing attention that National Geographic and Smithsonian magazine are giving to real science, something is going on out there--something that seems to substantiate the idea that Americans, in fact, are increasingly interested in science.

The Council for the Advancement of Science Writing with the gracious assistance of Rae Goodell commissioned one of Rae's students to make a preliminary and cursory survey of the literature on science reporting and come up with some intriguing information. The goal was to repeat a 1957 survey that CASW commissioned on who out there is reading science, what they want or don't want, what they are interested in, and what the attitude of the public toward science is, as well as the attitudes of publishers, broadcasters, and magazine editors.

The report by Sana Siwolop of MIT, "Readership and Coverage of Science and Technology in Newspapers and Magazines," does not by any means pretend to be complete. But it's a first stab at what we hope will become an exhaustive opinion survey. [This report appears in Section Two of this handbook.]

Once upon a time, science writers like myself were able to devote ourselves almost entirely to the questions of pure science. The late Harold Urey once said: "To those of us who spend our lives working on scientific problems, science is a great intellectual adventure. We are attempting to understand the order of a physical universe, vast in extent in space and time, and most complicated and beautiful in its details."

That's the kind of story all of us love to write--stories about fundamental explorations of the cosmos, from the smallest particles to the big bang theory. We still do as much of that as we can, but we've become much more than that now. In a sense I guess you'd call most of us writers on politics or at least writers on science and technology policies. Three Mile Island obviously is the biggest nuclear power story to come along the pike in a long time. But there are questions of nuclear waste and seismic safety and nuclear weapons proliferation as a result of the fuel cycle and the controversy over nuclear fuel recycling. We cover recombinant DNA. But where once upon a time it was an interesting laboratory experiment, it has become a very different kind of story. I remember recombinant DNA research. Charles Warren, the assemblyman holding the hearing, said, "If the scientists can start crossing the genes of plants and toads and I found myself with a house plant that croaks, I'd want to know a lot more about what's going on." It's our job in the press to let Charlie Warren and the public know what's going on. Warren, incidentally, subsequently became chairman of the President's Council on Environmental Quality, so I guess he does know what's going on now.

Questions like recombinant DNA or nuclear decision-making become difficult for us, and there's a tradition among many scientists and particularly technological people that what they are doing is really too complicated for the rest of us to worry about. I remember Chauncy Star, former dean of the School of Engineering at UCLA, later president of the Electric Power Research Institute, talking to what he thought was a private meeting of utility company executives; he didn't realize that a reporter was in the room. He said: "The public must accept the judgments of informed experts who have the public interest at heart; the technical issues are so complex that you cannot make decisions in public hearings." Well, he's wrong. The decisions are being made all the time in public hearings in one sense or another. They are being made by the government regulatory agencies like the Food and Drug Administration and in public hearings before congressional committees. All of these things mean that science writers today more and more are developing into politically aware, policy-aware reporters. In addition to the instances I've cited, we must write about the fate of DMSO, which is a public policy question now, not just an obscure piece of research by Professor Stanley Jacob of the University of Oregon, who thought it was a great thing for arthritis. We're writing about sexuality and contraception and abortion and cancer,

not just research in cancer, but the public issues. What do you do about laetrile? How do you present--in a reasonable, informative way, whether it's been published in the New England Journal of Medicine or not--the controversy over what kind of breast cancer treatment is the most useful, under which circumstances? These are issues the public wants to know about. They want to hear about the conflicting and contradictory schools of thought on the subject. They want to hear about the controlled experiments that go on. It's up to us to tell them about the double blind studies and what that kind of study really is. And it's up to us to be sophisticated enough to explain to people whether something has statistical significance.

All of these are a great deal different from the kinds of stories we used to write a long time ago. I would recommend, because it also relates to your business, an article that appeared in the New England Journal of Medicine on March 27, 1980 called "Gene Cloning by Press Conference," by Spyros Andreopoulos of Stanford University. It's the best piece I know that addresses this very central question of when and under what circumstances you should release material and what's the appropriate, ethical way to do it. [The article appears in Section Two of this handbook.]

It isn't only the people who plan press conferences who become involved in these questions. In 1977, Philip Handler, the president of the National Academy of Sciences, testified before a congressional committee and revealed a spectacular new experiment in gene cloning. The manuscript on the cloning was then under submission for publication in Science magazine. But Dr. Handler, to show the magnificent progress that recombinant DNA research was going to make in the immediate future, chose to disclose the information contained in that paper, which had not been accepted for publication--i.e. had not undergone peer review. He described it before Congress, which I think was just as bad as somebody swiping a paper that has been submitted to some journal without peer review. So it's not just the corporations that are engaged in the recombinant DNA race. It's the scientific community itself that at times is capable of violating its own concepts of peer review, its own highly ethical strictures on the subject. All of these things are issues we have to be aware of and wary of. They are issues in which you can play a highly significant role as key advisors on science and public policy to your respective deans, provosts, chancellors, presidents, and so on.

As I said at the beginning of this talk, don't ever believe that science reporters don't rely to an enormous degree on the press releases you put out, on your ability to recommend to us the right people in your universities to whom we might talk for background information about developing stories, to persuade those scientists and researchers that it's all right to talk to a reporter if a reporter really seems serious about needing the information. We depend on you to do these things, and above all we depend on you for your press releases. Some of them are lousy, and I think I can point out some of their flaws. Too many of them unfortunately are not really candid. They don't explain fully enough the significance of what they're reporting. Some of them go overboard. An example is the story of the first application of recombinant DNA in attempting to correct

a genetic defect in human patients. The first press release issued on the subject said, "The revolutionary techniques appear to be useful in the treatment of cancer," without much further explanation. Subsequent editions of that press release were revised to remove the word "revolutionary," and I'm glad that they were. But it seems to me that complete honesty in terms of appraising the significance of a story is an essential ingredient of a good press release, particularly if you recall that few newspapers and local radio and TV stations have experienced, trained, or knowledgeable full-time science reporters who can seek out the kind of evaluation that's necessary.

Appropriate timing is another consideration. As you know, there's an ongoing controversy over just what constitutes appropriate timing. I prefer very much when I'm talking about research results to wait until there's been some form of peer review, although certainly that's no guarantee of validity or significance. I remember covering a surgeon's meeting at which a paper was presented about the "miracle" of gastric freezing as a treatment for ulcers. The paper was published in a well-reviewed medical journal. A year later the same surgical team from the Midwest appeared before the same surgical meeting to announce that gastric freezing didn't work at all. Even the most prestigious journal can be wrong.

I'd also like to plead for a sense of historic perspective in your dealings with the press and in the press releases you put out. Beyond that I plead for an indication of who else is working in the same area, where they are working, and what they've done. I'd love to see enough background in a press release. And even if you're giving a plug to the University of Michigan while you represent Ohio State or vice versa, such background information can be very helpful to science reporters.

I shouldn't have to discuss clarity very much, except to urge you to make your news releases literate. Here are a few sentences from one of my favorite press releases: "Dr. Blank recently announced that scientists have identified a complex protein macromolecule that may be involved in cell growth regulation. Dr. Blank has found an enzyme system which produces ADP ribosylated protein in mitochondria.... A possible connection between mitochondrial function and macromolecular metabolism opens new fields of investigation into areas of medicine. The ADP ribosylated protein is uniquely reminiscent of the ADP ribosylated elongation factor 2." It took a little digging to find even a clue to what that was all about, and I don't think I ever actually did!

The last point I want to make is about providing access to sources. I find most of the time that I'm not writing about what was announced yesterday, a "breakthrough," an article that's going to be published in a journal and is embargoed until a certain date. More often I'm trying to write about people doing things in the laboratory in connection with a particular problem. I mentioned, for example, a policy-related question on contraception. If I were to do a series on what's new in contraception, clearly I would want not only to write about the things that have been

recently published, or the things that are immediately appearing in the press. I would want to go into the laboratory and talk to the people who are researching new types of contraceptive devices, chemicals, hormones, and so on. Again, this is where people like myself depend on people like you to help find our way through the vast academic structure to get to talk to the people who are at the forefront of that research, or who can provide provocative and stimulating contact with the research in the laboratory. I think it's extremely important for the lay audience to understand that any kind of science, any kind of research, is not a series of "breakthroughs," but rather is an ongoing process. And I think if together we can communicate something of that continuity, a lot of the Golden Fleece Awards would not be made by Senator Proxmire. I think he fails to understand the nature of the scientific process that I am describing. He fails to understand why a piece of research that apparently has no relevance, why things that seem to have no connection with reality--which win Golden Fleece Awards--very often are profoundly concerned with reality. But if they're put out as news in and of themselves, they really do seem silly sometimes. If they are used to fill in the gaps of what's going on in a given research field, they can be extremely significant and important.

One final thing: I urge you to try to help us by briefing your scientists when they do have a major piece of news to announce, when there is something that has just been published, and when you are bringing them into a press conference. It's a good idea to give them a thorough working-over to tell them what kind of queer ducks they are going to face out there, what they'll have to explain, and why it's going to be necessary to be simple and clear and honest. Here are a few sentences from a transcript of a press conference dealing with the discovery of virus-like particles in the milk of nursing mothers with a family history of breast cancer:

> Question by a reporter: "Are these particles viruses?"
>
> Answer by the scientist: "They are particles which are indistinguishable from others which we call viruses. That's caution. You're free to call them what you like, but I have my colleagues to worry about."
>
> Question from another reporter: "Would you make the general recommendation at this point that no woman should nurse in this case?"
>
> "No, no, no, certainly not. No, look, if a woman has a familial history of breast cancer in her family and if she shows virus particles and if she was my sister I would tell her not to nurse the child."
>
> Question: "Doctor, the publications we represent have a circulation of many millions. You're asking us to tell women to go out and get a test which is only available in your laboratory."

Answer: "No, I'm not telling you to tell them that."

Question: "Doctor, would you stand by what you said originally, which is for those women who are lucky enough to live near your university and who have a family history of breast cancer and who get into your laboratory and if your tests show up these particles in their milk that they should think twice about breast feeding their children?"

Answer: "Yes, that I would certainly say."

To have to coax that out of a scientist should be unnecessary. You should tell the scientist precisely how he or she should approach this question, which goes to the heart of a lot of what we do, particularly in medical writing. People tend to believe what we write and people tend to act on it. They run into their doctor's office waving their notes or the newspaper in their hand and say, "Doctor, why aren't you giving me this prescription?" Or, "Why aren't I getting this treatment?" Or, "Why can't you diagnose me more effectively?" What we write has this kind of significance; therefore, what you present us with has that kind of significance. So I'm asking you, in effect, to be our guides, to get the scientists on your various faculties to be our mentors and to remember that we as science writers have a rather special relationship with the scientific community.

Barbara Collotin, the news editor of Science magazine, wrote in the New England Journal of Medicine: "The press does not create issues, but it would be naive to argue that it cannot influence public opinion about them. The press has no obligation to protect or to defend science, though many researchers wish it did, but it has no obligation to be against it either. Its job is simply to report and to give perspective on the news." That I think is as good a definition I've heard of what our job is all about.

I'll close by citing a quote from Joseph Bronowski that addresses the public policy question again and its vital importance in society today: "There is no more threatening and no more degrading a doctrine than the fancy that somehow we may shelve the responsibility for making the decisions of our society by passing them to a few scientists armed with a special magic. The world today is made and it is powered by science. For any man to abdicate an interest in science is to walk with open eyes toward slavery." I think that's true, and it's our job to prevent that from happening by presenting science research in its context, in its continuity, and by addressing ourselves to the policy issues that flow from science and technology.

Question: One problem I think everybody has noticed is that when a news story appears in a newspaper, for example, on something to do with nuclear chemistry or nuclear physics, to the average newspaper reader that story is often in a vacuum and there's little background to make that story meaningful. What does your paper think and in general what do newspaper editors think about that, and are they planning to do anything about it?

Answer: I can tell you what we try to do on my paper. There are two of us who cover science, medicine, and technology, and we have somebody covering energy and somebody covering environment, and the fields obviously overlap. What we might do and have done many times is to try to do a kind of review article on what's new in a particular field. We try to do background pieces. We have a section called "Briefing." It has very little advertising and it comes out once a week. It has long articles, often reprinted from other publications, and not infrequently dealing with a subject that we feel the daily news story of 800 words can't really cover adequately. We try to run 2,000 or 3,000 words on that sort of topic. And more and more newspapers are doing this. That's why The New York Times has its Tuesday "Science Times" section now. Other newspapers, I think, are beginning to do that kind of thing because we recognize the need for it. And it sells papers.

Question: Can you see a conflict between your ideal of objectivity in reporting and your idea of getting more into public policy issues? And if so, what might one do to protect oneself?

Answer: Well, clearly, I don't think getting into public policy issues has anything to do with one's objectivity. You try to present whatever scientific evidence there is on either side of a particular question or all sides--if it's a complicated question. I will once in awhile do a piece that's clearly labeled "opinion" or "analysis," where I present a point of view. For example, we've had a big conflict out in California over what's been going on with low-level nuclear waste that has been dumped 30, 40, or 50 miles off the Golden Gate Bridge near the Farallon Islands. It was a dumping ground many years ago. It has become a political issue, and there was a congressional subcommittee hearing on the issue chaired by Toby Moffett from Connecticut. At the end of it I did an opinion piece that said, in a sense, "a plague on all your houses." Not that I was saying that the testimony at the hearing was invalid. I covered the hearing objectively. But I also tried to point out that this was a public policy issue in which scientists themselves honestly and on the basis of necessarily limited data were disagreeing. Some said there was a potential hazard and some said the hazard would be trivial under any circumstances. I tried to point this out and draw some parallels with other scientific controversies such as the recombinant DNA issue. But I try to put the issue in context. That's what I thought was a responsible thing to do, but it didn't destroy my objectivity at all.

HOW I COVER SCIENCE: NEWSPAPERS

Cristine Russell
Science/Medical Reporter
The Washington Star

David Perlman
Science Editor
The San Francisco Chronicle

Warren Leary
Science Writer
Associated Press

Patrick Young
Science Writer
Newhouse News Service

CRISTINE RUSSELL

The title of this session, "How I Cover Science," has a show-and-tell sound to it. I think if we were actually going to demonstrate to you how we cover science, we would be coming in here with truck loads of mail from our office, piles of phone messages, and the books and magazines that we all get. A lot of time is spent just sorting through the information we get in this very broad area of science.

Working for an afternoon newspaper, I'm considered a specialist. In my own mind, science is a very broad area, and I cover science from the health perspective across the board to general science topics. Perhaps because of my own interest and because of the perceived interest of our audience, I tend to spend more time covering the health area.

As a Washington-based science reporter, I also spend more time than other science reporters around the country do on the politics of science. In Washington everything has some political perspective, even if it's something as simple as a basic announcement from the National Institutes of Health. We spend a lot of time following the executive branch, following the Congress, and covering stories both on basic research and on the implications of science. For instance, if we're covering the Food and Drug Administration, we spend as much time on the political and regulatory aspects of issues such as saccharin as we spend on the basic question of whether it causes cancer.

Too many times the science-related topics that get covered today don't have any bottom line. We're covering things for which we have lots of questions, and very often the scientists or the experts that we're consulting with don't have the answers. So we are faced with trying to explain these problems to our audience, who may be very concerned with what we're writing. An example is the recent coverage of the toxic shock syndrome problem, which is something people are going to take very personally. The Center for Disease Control and the Food and Drug Administration don't have very many facts about exactly what this problem is. We can't really tell people exactly what the cause is and what they can do about it. We simply keep describing a changing problem as it goes along.

In terms of coverage, we in Washington do get a chance, fortunately, to get out of town to the real world. In the last couple of years I traveled with science writers on a fascinating trip covering science in China and also in Antartica. I also covered the Three Mile Island accident, which was science in action, but much less science and much more politics of a crisis nature.

My articles vary considerably, from very short stories that are phoned in (which is still done if you work for an afternoon newspaper) to longer feature articles. Our paper is now both an a.m. and a p.m. newspaper, so we are still trying to, as our ads say, put today's news today in the newspaper. So often we are faced with a very short deadline. For example, we hear someone at a Congressional hearing say 10 minutes worth of something and we have to create a story out of that--so that's what we cover at one end of the spectrum. Fortunately, in the science area, we have more luxury than many of our journalism colleagues in that we can spend an incredible amount of time on one subject. For one series I wrote recently on modern maternity, I spent more than two years researching the subject.

The sources of the stories we write also vary considerably, from the standard handouts or the journals (I feel we are very overwhelmed with information) to the things that we dig out, and those stories are always much more fun. I think we're being haunted a lot with press releases and nonstories, and I know a lot of you are in the position of having to decide what you will be sending to us. If I had to give any comment on that, it would be that if we got fewer releases on more important topics, we would all be happier. It's frustrating spending a lot of time just getting through the mail and discovering that half of this box that has been piling up for the last week contains announcements of people getting new titles. It would help if you would pare down what you're sending us. Send us things that are honestly important. Call us. Let us know whether it is a real story or a nonstory. It would make our job that much easier if you could make a side comment that maybe you were forced into sending out something for political purposes that may not really have that much importance or impact.

Also, I think in general the way we are covering science has changed. I don't think that we are any different in many ways than our colleagues in other areas of journalism. We are more skeptical. There is less of a "gee whiz" attitude in our writing of science. But I think that there is still more of an effort on the science beat to present the so-called balanced story, to let both sides have their say. We are neither allies of science, nor total critics of it. We are simply here to try to present those stories in the best perspective, and I think that is somewhat different than other areas of journalism right now. There is more of an effort in science to present that perspective but, of course, we all have biases. And in the end, we're all going to be fighting for space. For a Washington-based newspaper, 1980 was not a great year for science and medical news because of the campaign and the great deal of foreign news. We're really just fighting to get in the newspaper the same way everyone else is. So the kinds of stories we were looking for

last year had to be a little bit more attention-getting than they might have to be this year.

WARREN LEARY

Science writing and science writers are defined a little differently, depending on which newspaper, wire service, or broadcast station you are talking about. Working for a wire service in Washington, I have a very different job emphasis than Cris has working for a newspaper here. I spend very little time dealing with health politics and health science because of a difference in emphasis and in the way our two organizations use science. My emphasis is really on spot news, as such--developments that are happening that day and that are news that day. We get them out and move on to something else. Wire services are known for their deadlines. Sometimes I don't even have the luxury of 10 minutes to get a story out. We are more or less composing and thinking about a story as we are dictating it over a telephone.

Our audience is very different from a local audience here in the Washington area or any other area in the country. I'm essentially writing for everyone who can read in this country or elsewhere in the world, or anyone who listens to a radio or TV broadcast. So in many ways, I'm aiming at a more general audience than most science writers do. Therefore, my stories have to be shorter and more basic. My explanations have to be clearer in many ways than those of some other more specialized writers working on different newspapers.

With the Associated Press we have four science writers throughout the country--one here, two in New York, and one in Los Angeles. That's not very many people to catch up on what's going on in science in this country. We have a few people at other bureaus throughout the country who pick up, on a part-time basis, some of the science, technology, and environment stories happening in their areas. A lot of my time here in Washington is spent looking at what we call government science. I deal with NIH and the National Science Foundation. I'm writing about the results of research that is funded by different federal agencies, which means I have to cover a lot of ground. One day I might be at NOAA talking about weather climate research, the next day at NIH talking about fertility drugs. Next day I'm at the Nuclear Regulatory Commission talking about the steam generator and nuclear power plants. Because we cover a lot of ground, it's rather difficult to be an expert in any one particular area. The emphasis is really on the kind of story that would interest some readers somewhere. Every story I write may not be for everyone, but I'm aiming at some audience out there in the country that might be interested. I might do a story on an agricultural topic that I know will never be played in any paper on the East Coast. I did a story a year ago about growing disease-resistant potatoes. I didn't see that story in any East Coast paper, but my play in the West and in Maine was just incredible. So I have a very broad interest and some of it is "gee whiz" science or technology, the type of things that people will talk about at the dinner table at night. At other times I'm trying to explain what

recombinant DNA research is; what these regulations are; and how this affects you as you're sitting around the dinner table that night.

Like every science writer, I spend a great deal of my time going through papers--journals, mailings, and so on. It's an incredible paper burden, which is why I have a mailbox four times larger than any other reporter in my office. After a weekend I can count on having up to 300 pieces of mail when I arrive at the office Monday morning. It's no fun going through it all, but it's necessary to find out if there is any news there. I also have an extra burden of reading medical journals. The way the Associated Press divides its science coverage, different reporters in different geographical areas are responsible for monitoring certain medical and science journals to find information that might become a good story. For example, I read Science, which comes out weekly; Science 81; a monthly publication; and occasionally the New England Journal of Medicine. I read approximately 10 journals a week, which many times might include 200 or 300 studies but no story. So then the boss asks me, "What have you done this week? You've been sitting around reading magazines all week." "Well, not really; I'm just trying to find a story," I explain. If I don't read those magazines, as the boss puts it, and a story appears with our competing wire service or in The Washington Post or Star, I'm asked why we didn't have that. I say, "Well, that was on the bottom of the pile; I hadn't quite gotten to that one yet."

So there's a great need to go through all this paper and read a lot to try to keep up with different fields. I can't emphasize too much the need to cut down on a lot of the paper burden that is associated with the job. This would allow us to get to some of the stories we're missing, to have a better perspective on some of the things that we are writing about. Because we're here in Washington, we get a certain amount of paper from government agencies. This is in addition to everything we get from the universities and anyone else. And we have a certain responsibility to follow up on a lot of these stories, whether they're from the National Science Foundation, NIH, NOAA, or the Pentagon (sometimes we deal with technology in the military). So that takes a great deal of time and effort and adds to the whole burden of this type of job.

PATRICK YOUNG

I don't think I realized how different my perspectives are until now. When I was asked to talk on how I cover science, several things came immediately to mind--words like blindly, haphazardly, inconsistently. It occurred to me that in a sense I don't really cover science or medicine, not in the sense that it's all inclusive, science-wide or medical-wide.

I work for the Newhouse News Service, which has two functions. First, it's the national news service for the Newhouse newspapers, which are spread also haphazardly across the country. The Newhouse News Service also contributes to the field service along with The Boston Globe, The Baltimore Sun, and The Chicago Sun Times. So I'm writing for about 150

papers. All of these papers get AP and/or UPI. They are likely to get The New York Times Service, or The Los Angeles Times-Washington Post Service. The emphasis in my shop is to do something that nobody else is doing, which tends to cut down on doing news stories. I wrote my first and last toxic shock syndrome story in March, 1980. Other people discovered the story and went running off on it.

I probably do an average of two stories a week, approximately 1,000 words, seldom less than 800, seldom more than 1,200. I write essentially in a magazine style, and I'm always looking for good ideas. And there are plenty of them around.

How do I select a story? First it's got to appeal to me. I've got to be awfully interested in a topic before I'm going to write on it. I'm lucky in the sense that just about everything in science and medicine has some interest for me. The next consideration is what's going to bring a certain story or topic into print. Essentially, it's hitting me with the sense, "Gee, I didn't know that," or "Gee, that's interesting," or "I haven't seen anything on that." I'm also impressed if I've seen an awful lot on a topic. If I've seen a piece in the New England Journal of Medicine, a report from AP, or a couple of press releases on the same thing, I think, "Maybe there's a real trend starting in this area." I'll pull some of these things together and do an article. When I look at press releases, I'm looking for that element of "Holy cow! That's unusual; that's different; I can really get into that." I found myself reading a press release a few months ago and thinking, "Now, where do I fit into that pattern?" And it suddenly occurred to me that I was trying to figure out where I fit into that pattern. I produced a story with some pretty good play around the Newhouse chain.

Others talk about the decline of "gee whiz" science writing. I still am, perhaps more than most, a "gee whiz" science writer--not in the sense of hyping something up, but in the sense that I'm curious about the way the world works. I think there are a lot of people out there who are curious about how the world works. They want to know a little bit about it. They want to know about physics. They want to know about astronomy. They want to know about the basic science of medicine, as well as clinical medicine. And that gives us a tremendous opportunity to write in an interesting way because science in many ways is a continuing mystery story. You start with a problem; you have a solution. Often enough it brings up new problems. And there is that continuing sense of excitement that we can bring to many science stories.

DAVID PERLMAN

I want to tell you how we really cover science. A reporter on rewrite at the Chronicle not long ago got a phone call from a press agent. The reporter took a memo for the city desk, which read: "English faith healer, Ted Fricker, author of God Is My Witness, will expect a reporter and photographer at his suite in the St. Francis Hotel at 10:30 a.m. A copy of his book is in the desk and a sheet of press clippings on the

remarkable Mr. Fricker. On a swing through the United States promoting his book, Fricker has been healing a number of people of long-term illness and injury. Examples: Ralph Schrell, known to the Guiness Book of Records as the world's most successful complainer, was cured of his backache. Schrell is willing to confirm this and you can call him. Also Andrew Farkus, healed of a neck injury suffered in a trampoline accident two and a half years ago." The city editor (I was not serving as city editor at the time and maybe that explains a little something) told the assistant city editor to talk it over with me and my assistant, Charlie Petit, the other science writer on the paper. He wanted us to see if we "could come up with a wrinkle, such as having a doctor or two confront him or getting someone he can heal." Now that's the way a city desk assigns stories to reporters. Fortunately, I am not only older than our former city editor, but I have a little more clout around the office. We did not go to the St. Francis Hotel and we did not photograph Mr. Fricker. But that's the idea many city editors have of what a good science story is. And in a sense, he's right, you know. Most people would read that story. But it's so obviously and blatently a phony piece of nonsense that even The San Francisco Chronicle, which is not above entertaining its readers, declined to do it.

Of course, we do the usual things that my colleagues do. We read a lot of journals; we wade through enormous numbers of press releases. We try to decipher journal articles if we can. And we ask you to help us get access to the scientists, if we don't know them.

Fortunately, of course, most of us who have been in the business awhile have developed a kind of network of people we're likely to call on. The toxic shock syndrome story is an appropriate example. We call up the chairman of the Department of OB/GYN and get the name of somebody who's doing some work on it at the university--somebody local. But if it happens that the best scientist is at Harvard and is somebody I know, I'm likely to call that person. Telephones are easy to use and they're not very expensive any more. We have networks of people we've come to rely on around the country. We've met them at meetings. We go to the AAAS meetings to get stories to file, but also to build up a backlog or background information and to meet people we can call later, if an issue comes up that we need information on. We may also ask for the kind of information that only a really good friend will give you: "Look, I've just read an article in Journal X by so and so. Is that guy a phony or not?" We can get that kind of answer if we develop relationships over a period of time. I ask those of you in public information: If you have a chance to sort out some of the phonies at the institutions you represent, in some way communicate your inside knowledge to us without ever saying enough to get you fired. That would be a great favor to us because sometimes we have no way of picking out a phony. For example, I did a story once about some research at a university involving some trials of a particularly interesting brain hormone. I talked to the head of the service and learned what was going on. I asked him if anybody else at the institution was involved in this work. "Oh no," he said. "We're the team doing it." I had no reason to disbelieve him, and I wrote a story

on his work. I got a phone call the next day from Dr. X saying, "Doctor Y didn't tell you that my team over in the lab down the hall is doing the same kind of work and we have some interesting results that have been published. He didn't mention that, did he?" I said, "No, he didn't. In fact, he said there wasn't anybody else working on it." I knew both of these people, but I didn't know the second man was working in this field. Now, the first man obviously is never going to make it into The San Francisco Chronicle again because he was so jealous of his little empire that he wasn't about to tell me that anybody else was working in the field. I didn't have the wit, as a matter of fact, to have asked the same question of the public information representative of that institution. If I had, I know her well enough to know that she would have told me honestly that Dr. X was involved in the same field. These are some of the things that we try to sort out, and we need your help in sorting them out.

Question: Do you see a difference in the coverage of science and research, including medicine, between the West Coast and the East Coast?

Perlman: You mean, do we see a difference in the way it's handled or in the kind of science that comes out qualitatively?

Question: A little bit of both.

Perlman: I'm on the West Coast, and the job is two-pronged. One is keeping tabs on developments elsewhere that relate to stories I'm working on. They may or may not be local. There might be national issues. The second is covering the local science scene. And if you happen to live and work in the San Francisco Bay area, that alone is enough to provide you with a story a day for the rest of your life. And then there are the national meetings, where you don't care where the person comes from; it's the subject that's the most interesting to you. I don't think about the geography of it at all. But it's natural that in a newspaper on the West Coast there's going to be more science from the West Coast. George Alexander can rewrite the same story about seismic research 50 times and get it in the L A Times at 2,000 words a crack over and over again. That's what's happening in his area. And it isn't often that he'll do the same thing about Ohio State. The same thing is true with me at the Northern end of the San Andreas fault. So sure, there are qualitative differences in what we do. We are both local and national, and that's the difficult part.

Russell: I think most full-time science writers like to think of ourselves as nationally oriented. Obviously, we're going to do more in our local areas. In Washington, we could just keep circling around from one scheduled press conference to another. We may get a lot of press releases and such from around the country, and, again, I think we are overwhelmed by paper. Occasionally I do get very nice phone calls out of the blue from institutions or people I'm not familiar with, and they give me some very good ideas. I don't think we hear enough from the institutions that don't have huge public relations staffs. So if sometimes we are slighting various areas of the country, it may be because we're just not aware of

what's going on. In our office we've all got computers now; so it's easy to sit down at a computer and push national wires and go around the country and see all the stories being sent out from this place or that place. Sometimes I'll see a local science story from somewhere and say, "Gee, I wish I had known about that." Maybe I have a press release on it in that giant stack of mail I got that day. So often the institutions themselves tend to think very locally, and they may feed the information to their local wire service reporters or their local newspapers and then stick it in the mail with a random or immediate release date. If I get that in the mail, I don't know how old it really is. We have a terrible mail system just within our own building; I don't know how long a release takes just to get to me. I think if we had better input from around the country and better knowledge of important stories and not just routine things, there would be better coverage from all of us, even though we're located in different parts of the country. We would all like to do national stories, and we all have some opportunity to travel and a capability of talking on the telephone for endless hours. I think that we would change if we had more input on important stories and also had these stories on time. None of us is going to do a story two or three days later that was big and broke somewhere else. We may do a followup later, but we're not going to do the basic news story three days later.

Leary: To some extent we really are slaves of our geography. If we're in a certain area, we're covering the things in our area more than things elsewhere. Over the years, though, we've been getting out of that. Some of us in any case do what Dave Perlman mentioned--we develop our contacts, people we've dealt with before and can call again. If I'm writing about a certain topic and there's someone in that field that I did a story on two years ago, I can call this person wherever he or she is and ask, "What do you have to say about this?" And over the years I have made an effort to try to reach out of Washington, to go out of the East and find some of the scientists in the Midwest and other parts of the country. It's a slow process because, as Cris said, you just don't know what's going on out there. Over the years, I've met public information officers from other institutions, and I've asked them to put me on a very select mailing list so I won't get everything they send out, but just the big stuff. Sometimes these people are unsuccessfully dealing with a local AP office whose reporters are occupied with other stories and don't have time to deal with a science piece. Some information officers will call me or someone in our Los Angeles or New York bureau and say, "I'm from Toledo and I can't seem to get the bureau here interested in this story, but I think this might be something you'd like." I can write that story from here or one of our other science writers can write it from Los Angeles or New York. That way we kind of bypass the local bureau. So you have to kind of keep us in mind for things like that. Emphasizing the point that Cris made, we have to know about these stories in time. It doesn't do us any good three days later to get a release marked "for immediate release" and not know when it came out or how the local papers played it. In my case, the local AP bureau may have picked up this story and run it on the state wire just for that particular state. In that case, I'd have difficulty doing that story again for the national wires because it has already been out and I don't know how widely it has been disseminated.

Yes, we do have a certain prejudice for our geographic area. But there's a willingness to break out of that if we know what's going on and if people try to contact us about the important things, not the trivial ones.

Young: I think that information officers are in a position similar to that of free-lance writers--you've got to know your market. Whether you're dealing with your local media or the national media, you have to have some idea of what they're writing and what their approach is; then pitch your subject to that publication or writer. Many of the press releases I get might be good for a local paper or the local office of the wire service, but they're not going to do much for me. Also, this network that has been mentioned is very real. We talk not only with scientists. We have built up our own little pool of information officers around the country whose work we respect, and we occasionally exchange notes on who is good. It used to be called the old boys' network and I guess now it's the old persons' network. It's composed of those whose work you respect and who haven't led you astray. I remember interviewing one scientist who gave this absolutely brilliant and lucid explanation of some work on the moon. I was all set to go; I had this great story until I found out he was the originator of the theory and the only true believer.

Question: Is there a geographical difference in faculty members? What is the hardest geographic area in the United States in which to work?

Young: There's a researcher at the University of Minnesota right now who isn't at all friendly. I was told by his secretary yesterday that Dr. So and So does not wish to be interviewed at this time. That's another problem we run into. And it's helpful sometimes to have an information officer who will open the door for you, if you know a scientist is going to be difficult. There is a lot more research going on on the West Coast and the East Coast than there is in the Midwest. Also, I think, the East Coast and the West Coast for the most part tend to have higher pressure and better organized PR offices. I think that very much plays a role. Johns Hopkins gets a lot of play, not only because it's a fine research institution, but because B.J. Norris and the crew up there are very aggressive, knowledgeable, and helpful. And that counts for an awful lot.

Perlman: Two points that Pat made are worth underscoring. One is the availability of information people on campuses who can steer you to the right person. If I call UCLA to get a story and I don't know who the right person might be, or if that person has never heard of me, I can ask Al Hicks at UCLA to tell the scientist that I don't have horns. That's a very effective way of having somebody pave the way for you, even if the scientist doesn't normally want to be interviewed. And then you can assure him or her that you're bona fide by asking an intelligent question. Ninety percent of the time if the story is in an area you're not really familiar with and you ask an intelligent question, the scientist assumes you know a lot more than you do and he or she gives you an answer right out of Physics Review. So that has problems associated with it.

Russell: I agree that it does help to have information officers help us get to these people. Often it helps if it can be explained that we're spending all of our time doing science writing, and that gives us more experience than someone who's starting off doing his or her first science story that day. And I don't think there are any geographic differences. I was out in California recently begging a couple of scientists for interviews. Because of their bad experience in the past with the media, they were uptight and would not say a word; they looked perfectly relaxed, but what came out of their mouths was not. A lot of scientists are very nervous about the media and they need to have some reassurance that we are not going to use "breakthrough" in the first sentence of our story. Very few of us have used it in recent years. We're a fairly cautious lot, and we're looking for good stories, not necessarily sensational ones. I have a problem, occasionally, when I call a scientist out of the blue and say I'm from The Washington Star. Well, they just hear the "Star" part and think it's the National Star you find in the grocery stores. So I have to convince the scientist that I'm calling from a daily newspaper in Washington. Often we have to explain ourselves or beg our way in the door. But I don't think there's a difference in scientists in terms of geography.

Question: Mr. Leary, could you give us some guidance on when to deal with local AP bureaus on a science story and when we might be better off going directly to you or the science writer in the region? Are there times when the local bureau might dismiss the story with a few paragraphs, when the national science writer might recognize it as being a more important story?

Leary: There are a lot of situations like that. Every once in awhile I go to our library, where we file everything coming from across the country. I'll see 200 words on a story and think, "How could they have missed this?" I saw a story out of San Francisco about the world's first testicle transplant, which somehow our bureau managed to condense into 200 words and let die. It was a story that just begged to have more done about it. I called about it and someone at the bureau said, "We were kind of busy that day and he came in and we got it on the wire." You just go crazy when you hear things like this. The information officers can look at their stories and know whether they have some kind of national impact. Does the story concern anyone else outside of the state or region? If it might have a national impact, then they should consider dealing with one of the national science writers. Of course, some stories are more local and very confined in their impact. I deal with people in Maryland Sea Grant occasionally, and they'll come up with an oyster study having to do with part of the Chesapeake Bay. I may feel it's really interesting, but I can't sell that to anybody else. If they call the Baltimore bureau about that, that bureau may get a nice state story out on it. A university in the East recently did some interesting work on stack scrubbers from steel plants and some of the different pollutants that are concentrated in these scrubbers. I saw in that a little bit more than a local story or even a steel industry story, and I was able to make a national story out of that. It's just a matter of looking at what you have and seeing if it has any implication beyond your

area. Also, local information officers should consider developing a personal relationship with someone in local AP or UPI bureaus. A bureau usually has a news editor, someone who does the assigning and is the gatekeeper of the news coming in. It doesn't hurt to get to know this person, to visit the bureau so this person has a face to connect with the name. Sit down and talk with the bureau people and tell them you're not going to bury them with a lot of paper, but when something substantial comes up, you'll call and let them know. In the way this whole system is structured, it helps if you develop a personal relationship with the local AP or UPI person.

Question: If we contact the local AP bureau with a story that may have national impact, will the local bureau alert you at the national office?

Leary: No, they probably wouldn't. They'd do it as a local story. The local bureaus can have a good story and control it statewide or in a certain region. Then they have to ship all these stories to New York, where there's one desk that decides what goes on the national wire. Depending on who is sitting at that desk that particular day, he or she might say, "Gee, this is from Indiana. If it's good science, it wouldn't be coming from Indiana," And that person then doesn't put it on the national wire. But if I write the same story from Washington and it has my name on it, the person at the desk may say, "A science writer is doing it; therefore it's a national story." And that person will ship the same story out on the national wires. You have to deal with the local bureaus and see how you do with a number of stories, If you're not getting any satisfaction, try to expand and talk to some of the national writers.

Question: How important is it to put out lists of the experts we have on campus?

Perlman: Several universities periodically send out a list of people who have certain kinds of expertise, These are useful if the field of expertise is adequately defined. In other words, to suggest that Dr. So and So is a fine seismologist would not be particularly helpful. But if the scientist's area of interest is very specific, for example, if the scientist is conducting laboratory tests on the breaking strain of granite, that would be a useful thing to know if we do an earthquake story at some time. If you structure such a list giving us a really clear indication of the scientists' fields of interest and what their accomplishments are, it could be useful.

Question: How often do you come out to a college campus and actually attend a scientific conference?

Russell: It depends. We all travel a certain amount and maybe we fall into a rut of traveling to the same meetings every year. Often we'll get a brochure in the mail or a program and think the program looks very interesting, Then we call to find out what kind of arrangements there might be for the media and discover that there's going to be nothing. It's a little bit discouraging sometimes to come out for a meeting and

discover we're not going to get any papers or anything we can put our hands on. I think it depends on the arrangements--not that we all want to be totally spoiled, just a little bit spoiled. I think mainly we just want someone who will help us once we get to the meeting, especially with the very specialized meeting. We need something to help us get through the technical jargon to find some interesting stories. Often the small specialized meetings don't get covered because they're not really set up for us to attend.

Leary: Often there will be a three-day meeting at a university campus. But we cannot spend three days covering a specific meeting, so we want to be able to talk to someone and ask what the best sessions will be. Often the information officer we're dealing with doesn't know. We want to know if abstracts or papers will be available. Often the information officer doesn't know and says, "Well, just come out and spend three days with us." We really can't do that. But it's helpful if we can call someone who will tell us which session looks good, who will be at the meeting, if the scientists will be available after they give their papers, and so on. This allows us to channel our time, go to a few sessions, and get some news or at least some good background for a future story. It requires a little more than just telling us that there's a meeting at the university that could be kind of interesting.

Young: I'd like to add one plea: when you're bringing your scientists out for the occasional dog and pony show, please tell them not to underestimate the intelligence of science writers and overestimate our knowledge. I cover everything from space to psychology to medicine, the hard biosciences, and the physical sciences. I've got a smattering of knowledge in some areas; almost none in others. I like to work out with the scientist the level that we'll eventually talk on.

HOW I COVER SCIENCE: RADIO/TV

Edward J. De Fontaine
Managing Editor
AP Radio

Robert Bazell
Science Reporter
NBC News

EDWARD DE FONTAINE

While it's not necessary to have a science department to have science on the air, it's also not necessary to have a radio and television department to get science on the air. Even with an organization like ours, which has no science department of its own, there are hard news connections with almost every field of science today. Primarily the topic of interest that brings that to the fore is energy. We're interested in pointing out not only the advances that have been made in science, but what your particular institution has to offer and the efforts that you're putting forth.

You really must have the knowledge that you have somebody who can speak authoritatively at a moment's notice on a topic that happens to be in the news of that day when you're approaching an organization like Associated Press Radio, which does not have a science-oriented program and does not have a science reporter as such. We do have an energy reporter who spends about 50 percent of his time on that beat. You also have scientists who are going to be in the news from time to time. The better universities and research institutions take advantage of that by making their people available and by publicizing the advances they have pioneered and the fields in which they can offer expertise when somebody else produces an advance. You also have people who are personalities when they win an award, when they appear in the news because of conferences in their field. And in many of those cases you're talking about a local radio or perhaps television opportunity. When a national convention is involved, you have the ability to get on a national network--ours and the others--because the forum is important and your man or woman is an important part of that particular function. The lesser the forum--for example, if it's completely science-oriented--the more problems you'll have getting on the air. During the question-and-answer session we'll talk about the specific problems you face in getting your material in front of our editors.

You should be prepared to give a radio station or a network the best quality audio for radio or the best picture potential for television that you can. For radio, you certainly need at the very minimum a cassette tape recorder and the knowledge of how to hook it to a telephone to conduct an interview with good quality over telephone lines. Most of these contacts will be made on a moment's notice and you should have

people who are ready to go to the phone when a query is made. Our organization will ask for your cooperation when we need the material, when the story has come to the fore and you have the expertise. You also should make us aware of the people you have available. Some institutions do this to their great advantage. They outline the spokesmen they have and their availability, the fields in which they've accomplished something of national or international note, and then tell us to whom we should go to make the contact (seldom will they give out the person's private number). Making a list like this and distributing it to national organizations like ours and to local and regional stations will affect the effectiveness of your fund-gathering, which is an important part of why you have a job. Then you can sit back and wait for the story to develop, or you can think of an angle when a story develops that a newsperson who's not science-oriented might not think of.

Therefore, you should make a certain number of personal contacts, be it by telephone to distant places or personally to stations in your own backyard, to make sure that you know the news director and the program director. And remember that news alone is not the only exposure your people can get. There are talk shows that are not run by news departments. And there are appearances on local programs where expertise is required that are not run by news departments. So you don't want to limit yourself to the news department alone. When your person does agree to be your spokesman in a certain field, you should make him or her aware that the questions that will be asked might not concern the scientific advance alone, but also the effects on the listening public, on ecology. It might not be an interview in which the spokesman will be approached on a purely positive basis, so he or she should be prepared. I suppose this is especially true for television because the surprise in a person's face shows more than it does in a person's voice. Your spokesman should be prepared for questions that are going to be critical, if only from the point of view of the correspondent being the devil's advocate.

ROBERT BAZELL

I work for the network and have never worked for a local station, which is probably what you deal with more than you deal with the three networks. One of the biggest problems I face in coming around to do a story is that the scientists are angry at what they perceive as the bubblehead from the local station who came in and interviewed them a few weeks ago and didn't get it right. So they wonder how I can possibly get it right. And I'm not saying that I always do get it right; of course, I make mistakes. But that seems to be a real problem.

I essentially do two things for NBC. One is a weekly spot on the "Today" show that runs on Thursday mornings, which has been going on only since the summer of 1980. I'm very happy about it because it gives me a chance to do feature material. I do basically anything that is vaguely connected to science that I find interesting and that I can subsequently convince the producers of the show would be interesting, although they pretty much

leave it up to me. This has ranged from things like an interview with a scientist at UCLA the morning after The Los Angeles Times revealed he had done genetic engineering experiments on human beings, to a story about the walking catfish in Florida. I'm not going to cover nuclear physics if I can't make nuclear physics interesting to myself, first of all, and to other people. And I'm looking for things that are visual.

The other thing I do is cover breaking news for both the "Today" show and the nightly news. This is when we are in a panic situation. We're coming into your campus, and unlike radio, we can't interview you on the telephone. We have to get a picture. We have to do an interview with the scientist who doesn't understand why, if he just said this on the telephone to somebody else, he has to sit down in front of a television camera and repeat what he has already said 15 or 20 times.

In terms of the features, I can't emphasize too much that we really depend on you, the public information officers. I don't know what's going on at 10,000 universities across the country, except what I learn from reading the journals, hearing from you people, and talking to scientists on other stories and asking them what else is new. Interestingly enough, the latter is my major source of stories. The scientists usually do better than the public relations people in putting something into perspective and saying that this is really interesting. Not all scientists do; some of them haven't a clue. But they usually see connections that I don't get in a news release. And there's no shortage of material out there, particularly because of the wide diversity of what is potentially a good piece. It would be nice to have as much input as possible from the institutions. It doesn't have to be at Harvard, and it doesn't have to be affecting everybody's lives to be interesting, although affecting people's lives obviously in journalism makes something news. It's not the only criteria, but it's important. Is it going to change the weather? Is it going to make people healthier or sicker? That's a story you can always sell.

Question: What exactly is Associated Press Radio?

De Fontaine: This is a wired network, the same as the commercial wired networks are. There's a 24-hour constant contact. We are currently moving toward satellite, but there are only about 20 cities affected so far, perhaps 100 by the end of the year. We provide basically a hard news product; there is some feature production, as well as public affairs production. It is usually hard news-oriented, either in previewing or in assessing the aftermath of a story.

Question: Why do you say that we need a tape recorder?

De Fontaine: If you're in Ann Arbor and we're in Washington, it's better to have a tape recorder when you're using the telephone to feed us news. It's always advantageous to be on the Bell telephone system. If you use another company, sometimes the quality you get out of the lines is not as

good as you would get from Ma Bell. No matter what anybody says about the rest of the organization, it does provide a good service. If you have a tape recorder, you can amplify your scientist's voice by recording him or her on a good microphone, rather than using the carbon microphone that's in the telephone. There's a great difference in the signal-to-noise ratio. So you start out with a better product. When you have the advantage through microwave or even satellite of avoiding the limitations of hard-wired circuits, you can get a very good quality interview on a telephone line if you pre-record it. If the scientist has done something at your university or has made a speech, you can feed excerpts from it to us. If we're talking to your scientist, you seat him or her down at the microphone with the tape recorder next to it--it does not have to be recording; it's sufficient if it's in the record mode. Or you can make your own copy of what the scientist has said and feed it to us at the same time. It makes a big difference both in the loudness of the signal, which affects signal-to-noise ratio, and in the quality of the material because you're using a better microphone. It doesn't have to be expensive. We're talking about $150 for the machine. You should invest in a microphone a shade better than what comes with the machine--but only about $25--and a pair of what are called alligator clips connected to a mini plug, which will fit into the speaker outlet of that machine. Then you're set up to do a decent job of providing audio.

Question: What do you mean by hard news, fast breaking news? And how amenable are you to broadcast-ready material?

De Fontaine: We are a news gathering organization and we are really not interested in broadcast-ready material. We are interested in asking your scientist questions or, if he or she has given a speech that has made news, we're interested in being able to get excerpts from that speech. It is then either the forum before which the scientist has been speaking or the scientist's revelations that have made news, so it does not necessarily mean that we have to talk to the scientist, if the speech itself or the scientist's appearance has made news first of all. But we are interested in talking to your scientist in order to play off of a hard news story--to determine the effect it is going to have on the public or the importance it's going to have economically. This is our view, and not necessarily that of a science reporter, who might be interested in the raw information because of its importance to science itself. But in our organization, with our format, we would be interested in talking to the scientist if he or she has a comment to make or some information to divulge on a story that's already in the news.

Question: Do you pay attention to what is happening in Canada?

De Fontaine: Speaking for myself and for the people I work with, if you send me news releases, I certainly would not ignore them because they were from Canada. I cover the entire United States, and Toronto is a lot closer than most of the places I seem to be visiting, so I would have no problem if it were definitely newsworthy. Despite the fact that we don't have a science editor, a person assigned to that beat, an editor opens every piece of mail that comes in to see if there is anything of news

value. We sometimes find that a university, in sending out information on one story, informs us of an expert we might use in a completely different story. There are universities with medical schools that have provided us with sports stories when, for example, the use of drugs in any field of sports comes to the fore. In your particular case, we would probably know about anything you send out, if you provided it to Broadcast News of Canada, with which we are affiliated. But we would like to know about it individually and directly as well in Washington, DC.

Question: Doesn't AP Radio have Canadian news?

De Fontaine: Yes, we do a Canadian newscast every day. However, very little of that would be science-oriented because it's really news of the day for people who are down here from Canada defrosting in the winter.

Question: How do you like to be contacted? What is the best way that we can get information to you? By letter or phone call?

Bazell: I find phone calls are very valuable if something is legitimate breaking news. If you're calling up to talk about a possible feature or something, you're not going to get through, and it is really a waste of your time and money to make the phone call. News releases and/or letters are about the same. Everything that we get is read. It doesn't get ignored. Most of it eventually is discarded, because 95 percent of the news releases don't lead to stories. But that doesn't mean you shouldn't send them because that 5 percent is what we are in business for.

De Fontaine: On a breaking story, where you know that you have an expert, please phone, and I'll give you a WATS line number so that it doesn't cost you a penny inside the United States. Sorry, Canada. But it is true that if you phone to tell us that you have someone who's going to a convention, that he or she is going to deliver a paper, you will probably not get any reaction. However, if the scientist is going to a very important convention and is going to make a very important declaration or revelation, please let us know. It's better to call once too often than not enough. If you are going to propose a feature, it's probably better to send a letter than a news release. The press release, as such, does not tell us how you think we could best use that material. And in our particular situation, that is an important part of your approach to us, and your job would be to outline a few ways that you think we could best use that material. You might hit upon the jackpot and get yourself some national publicity.

Question: Wouldn't it also be very good in your case to work with a station in your locality that carried AP Radio? Would it give our news more credibility if the station you work with calls you?

De Fontaine: Every one of these organizations, the commercial networks as well as AP Radio, uses member stations as a source of news. If you have a good rapport and can explain your story to a news director in your community whom we recognize as a good news person, a call from that person would probably be effective because he or she would tell us the

material's news value and probably would not have picked it up unless it were a news story. Now the material might be so localized that we wouldn't be able to use it, but that doesn't mean it wouldn't be a good approach. If, however, you've been ignored by your local facility, and you are sure you have a story or someone who can comment on a story that has already developed, don't let that deter you. The fact that the local news director is a good news person doesn't mean that he or she has a great knowledge of what is important in the field of science. So give it a try if you think your story truely has merit.

Question: Would NBC use a story coming from the local television affiliate's studio?

Bazell: Only if it were a breaking story and time constraints made it necessary. If the local station has a good story, it may get on the "Today" show as a spot news item done by the local reporter. Or, there's a service call that all three networks use, a feed that goes out to the local stations through the network that every local station in the network can use for its own local news. And that's not something to be overlooked. It's a very important outlet. Millions of people see it. But if I were doing a story and I had any chance whatsoever to get to your campus with my own crew, I would do that. Affiliates work for a different corporation than NBC, and they have their own needs and their own types of equipment, which often aren't compatible with ours. We like to do a story ourselves if we possibly can, but sometimes there isn't time if it's really crucial.

Question: Do you pay much attention to institutions in the Midwest?

Bazell: I seem to spend a lot of time in the Midwest. Send us your material. It's no less valuable because it comes from the Midwest, from my point of view.

De Fontaine: Anyone from an institution that has a School of Agriculture should remember that AP Radio does five agriculture shows a day, and there aren't that many developments coming out of Washington, or enough stories about the growing season or grain sales to China to fill these programs. We are actively seeking anything about innovations in agriculture, be they scientific or managerial, that would be of interest to the agricultural community. There's a natural for you. Any institution with an economics department should remember that we do a business program, and I know television has a great interest in economics stories. There is a possibility there of having a noted economist comment on an event on any given day. There's one thing to remember when you have someone who is successful enough to win something like a Nobel Prize or any other major award--don't let success go to his or her head and have that person then refuse to pick up the telephone. That's when you can cash in on publicity without any effort on your part because the story is already there, and your expert is a part of it.

Question: Regarding experts, is it a more valuable approach for us to send you a general list of which experts on our campus can talk about certain issues?

De Fontaine: The list is the first step. However, when you recognize that you have somebody who can comment on a breaking story, you should also make the effort to let us know at that time. Our WATS line number is 800-424-8804. You should always make the effort to let us know if you're really sure that you have a contribution to be made to a breaking story. When the editor goes looking for someone who is knowledgeable on a certain issue, he or she probably has already 10 or 15 universities in the card file, and if in the meantime you phone an offer and the editor wants comments from only one expert, your effort will pay off. The editor is usually looking for somebody who can explain an event or issue in lay terms, but from a scientific point of view.

Question: We don't have that many really great stories in our university, but every once in awhile we do get calls from radio stations inquiring about various feature and research stories that we've done. They seem somewhat put out when the faculty member is off in a hospital somewhere and not available to talk right then. From your point of view, how much does it decrease our chance of getting publicity if the faculty member is not immediately available for a story that is not a breaking story?

De Fontaine: I believe it makes a great difference if it's a hard story. If it's a feature story and your person is the authority, it shouldn't make any difference.

Question: To whom do we send information about agriculture news?

De Fontaine: Generally any of this information can be sent just to AP Radio without a name. The agriculture editor's name is Joe Kafka, and our address is 1825 K Street, NW, Washington, DC 20006. But if you forget an individual's name and you send off a release or a list, you can rest assured that it will be passed to the person involved. It it's a complete list it'll be broken down and your agriculture experts will be sent to Joe, your economics experts to our business reporter, and so on.

Bazell: While we are on the subject, let me give you my address, too. It's NBC News, 30 Rockefeller Plaza, New York, NY 10020. And just send the information to me.

Question: If we have a good feature idea and send a letter, how long can we reasonably wait to find out if you're interested?

Bazell: A week. Just allow for the mails. My policy is I'll always call somebody back right away, if I'm interested, to talk about it. There are certain things concerning picture possibilities and the availability of the people and so on that we want to get sorted out before we even think about whether it's a story.

Question: If I want to give you an exclusive, is that appropriate?

Bazell: From our point of view, sure, I love exclusive stories. From your point of view, it's a great mistake, unless you feel that somebody

does an exceptionally good job on that type of story and will do the story the way you want it done, while others won't. Exclusivity doesn't do a thing for you. But don't let that hold you back if you want to phone me with one because we like to have them. But from your point of view, I think that's a mistake. The other university in the next state might have that development next week, the way science developments go, and then you'll lose out.

Question: It's sometimes difficult to get the cooperation of scientists in trying to put out a release. Do you have any comments on this problem?

Bazell: Very interesting. And one of the real problems with being a public relations person is that you really have to be a reporter, in addition to all your other duties. I know that it's tough dealing with scientists, and I really sympathize with you. I know what it's like to go back to some lab and start trying to shoot the breeze with these people and say, "Hey, what's new and what's the significance of this?" And they are going to say, "Get out of here; who are you?" I know you've got that problem. You've got to put the development in some kind of context; you've got to understand that this is really interesting; and you have to believe that you'd like to see this on television. You can't send out a release thinking the subject isn't very important, but maybe you can put one over on us. You can't think you're doing your job just by getting out news releases. If you think the subject would make a good story, if you honestly believe it, that's the beginning.

De Fontaine: One thing to remember in broadcasting is that nobody is going to take your release and write a story off of it. Someone will have to go out and generate either film or an actuality, even if it's by phone. It takes effort on our part, so it's not like sending a release to either the news agencies or to a newspaper. If you don't make it interesting, it won't attract our attention and won't seem worth the time we're going to have to spend to produce the story; we probably aren't going to do it if we don't read down to the bottom where you buried the lead. So put the lead on top. That's the important difference between sending out releases to your local and regional newspapers and to broadcasting operations. We cannot write off of your release. It's going to make absolutely no sense to have a story on science without the expertise of the person involved in the development or without the institution that produced the development. So it takes effort on our part and it is not going to be rewritten right off of your copy.

Question: TV needs a visual angle. There's a lot of scientific research that is very significant and very esoteric, but there's no visual possibility, other than a picture of the scientist talking about it. Is that always a concern?

Bazell: It is a concern, but I would maintain that what is visual and what is not is a lot more sophisticated than that. I have seen very few stories where you can't take pictures. The scientists are usually doing something, except perhaps in theoretical mathematics, where the person is sitting down and literally just working with figures or sitting at a com-

puter. Almost everything involves some activity. The scientists will tell you quite often that there are no visual possibilities. But in fact, that should never ever be the first consideration of whether something is a story or not. God help us when that becomes television's sole criterion. If a story is important, there should be a way to do it. We have graphics for example. We have animation facilities in New York and Washington, artists who can draw pictures for a spot, and all kinds of other ways to make a story visually interesting. So that should not be your first concern.

De Fontaine: There is an area in which we are interested in even straight voicers. If you have a regional convention going on, we have a regional service that covers stories that do not have a national impact. If you have a great number of educators or scientists from a multi-state area, it's not going to attract national attention, but it would still be useful on our regional file. Again it's the same WATS line number. We are more interested in the actuality than we are in the story, although, if it did not receive national attention, you'd have to be prepared to give us enough of a story so that our billboard would make sense.

Bazell: In terms of television, there seems to be an increasing popularity with sending out video tapes from institutions. The number of video tapes I get seems to be rising every week. And every time I get a video tape, I think, "What a silly waste of money for the people doing this." The tape itself costs about $40, and making it costs God knows what; it's really a lot. And for me they're useless because the quality is never of the kind that I could broadcast it again on the air. By the time it got to the West Coast again, it would look like mud on your TV. So, again, we need from you words to tell us what a good story is; we don't need prepackaged pictures. However, if you have a story and want to illustrate what can be done with it because of the personality that you have on your faculty, you can send along a video tape as an illustration of how well the person speaks, how interesting he or she is, the type of information the person is going to give, and the lay language he or she is going to use to explain it. That might be of interest, and it might prompt a request from us for an interview with that person, either through a member station nearby or by telephone.

Question: After seeing some clips from "Universe," one of the concerns I have is the treatment of some of the scientific material in a manner that gives the audience a good laugh. But the problem is that some scientists or their projects end up looking ridiculous before a national audience. How would you deal with this kind of problem? It's the people like ourselves who would have to answer for it after the show is on. We get the letters, the phone calls, and so on. Why are you doing these ridiculous kinds of things?

Bazell: That is a difficult question. One of the reasons that I have a job is that the network thinks it's important to have a science person who is familiar with science and can stand up to some of the criticism, which is constant. Scientists, as I'm sure you all know, often don't think that

their work is represented fairly in the media, and sometimes they're right. But sometimes it's no different from any politician who never thinks that his or her great speech was represented properly in the media. People have their own set of ideas. When their story goes through somebody else's brain and gets considerably shortened, it never comes out quite the way they had in mind, unless they have some sophistication about it. That's one thing. Regarding the problem of seriousness, television can be ridiculous and trivial. In the "Today" show spots, which are features, I try to do light pieces sometimes. Sometimes we make things a little bit humorous because they are a little bit humorous, I think. You can't approach everything as if it were nuclear physics. But if you are doing a story that is serious, it should be handled that way. It's a question of judgment, and I can only say for my pieces that I stand on my own record. But I certainly wouldn't defend the television industry in this respect because there have been some serious abuses. It depends on who the reporter is, it depends on what the subject is, and there are going to be bad mistakes in any case.

De Fontaine: We are humorous, but we are never going to pull the chicken and egg routine if we are talking to your agriculture researcher about a new development in making egg shells harder and the like. This is very important in marketing eggs because if you can cut down the breakage, you get a better product. However, it doesn't mean that the story itself can't have some humor in it. I don't see anything wrong with having a light moment in a scientific story.

Bazell: In terms of public acceptance, that's also very important. One of the real problems I have when I go to the producers is that much of science seems ponderous. And, indeed, from the way it's presented, for instance on public television, it often sounds ponderous. Scientists will always ask why we can't be like "Nova" or some other program they like. And "Nova" does some wonderful, excellent shows sometimes. But some of the programs on public television, and not just "Nova," sound like bad lectures I used to hear when I was a student. And I don't think people want to hear bad, boring lectures. In the first place, a lot of people have bad memories about science in high school or college, and they don't want to relive it on their TV sets. So you have to be very careful. Often a little bit of humor can get a very serious idea across.

De Fontaine: One of the things that will come up, by the way, when you're trying to convince your scientist to go on the air, is the complaint that the brevity of broadcasting won't allow him or her to tell the story. The fact that individual pieces cannot be very long in today's radio format--90 seconds, even for feature length pieces--doesn't mean that we can't do more than one of them on the same subject. We can take a story or a development and tell it piece by piece with a reminder that there's more to come.

Question: How do you feel about radio as a competitive medium with television, and do you think there's a need to sell radio as a viable medium for science stories?

De Fontaine: It's harder to tell a science story where there are complications that the public does not understand and might not when the story is finished. It's harder to do that on radio than on television because those pictures tell an awful lot. And by demonstration, you can bring home a lot of scientific stories that would be very difficult on radio. That doesn't mean that we don't do them, especially when they're hard news related or have an effect on the individual in the audience. If we can relate your scientific story to the maxim, "Heart, Health, and Pocketbook," we'll have the listener listening. To have an audience understand the scientific development is harder on radio. But it doesn't mean it's not a radio story.

Question: Scientists from time to time are still somewhat suspicious of what's going to transpire during the course of an interview, particularly over the telephone. What is your reaction if the scientist asks in advance, "What are you going to ask me?"

Bazell: Our people have nothing against outlining what they are going to ask someone before an interview, if it is for the purpose of allowing the scientist to get the answer well in mind and be prepared to respond perhaps more intelligently and more understandably. But we won't put up with somebody who says that you can't ask this or you can't ask that. We'll ask it to make sure we find out why he or she won't answer it or to get the scientist to say that he or she will not respond. The scientist can have any answer to the question, but we won't submit questions in advance for clearance. Certainly, we'll be more than happy to tell the scientist the area in which we will ask questions, and it's every individual's right to refuse to be interviewed. So all the scientist has to do is say that he or she won't be interviewed or won't continue along those lines. That ends the problem as far as the scientist is concerned, except that he or she hasn't answered a question the journalist thinks is important to explain the story. As far as doing an interview for 10 minutes on the telephone or across the table and knowing that it won't appear on the air for that long, the scientist has to rely on the professionalism of the correspondent or reporter as much as we rely on the scientist's expertise and professionalism in giving us an honest answer. I know there are people in every business who'll disappoint us and you in what comes out on the other end, but we will try very hard not to do so. And if there is anything used, it won't even be out of context. If we use only a piece of a sentence because the scientist happens to be long-winded, we will try to paraphrase that sentence so that it stays in context. But I can't guarantee that you are going to have that sort of luck every time you bring one of your people to the microphone.

Question: Do you ever have any failures? Do you ever go after a story and then find half way through that it's something you can't really use?

Bazell: That happens all the time. It happens less with features. Even after we've started we can find we really can't use the story; it can cost a lot of money. But it's a risk we have to take to do a decent job.

De Fontaine: We'd need a lot fewer people in the shop if we knew that every time we made a call we'd get an interesting or informative response. Sometimes we phone three or four places. Often the first couple of places will have just the experts we need, but we discover they can't express themselves. That's something you will have to be aware of. If there are three members of your department and the head of the department is the real expert, you've really lost on radio if that person stutters, and you should save that person for the newspaper interview.

Question: Will we be able to find out when a story will be used?

Bazell: For network television it's easier. We always let you know.

De Fontaine: We'll be able to tell you at the end of the interview if the material is going to be used. But we don't have a clearance procedure and there is no guarantee that even if we have it on our 11 o'clock newscast it will be on your station locally at 11 o'clock. There is no clearance requirement on this service. The stations take and use what they need, so all we really can tell you is whether the material is going to be used on the service. The reporters will know that by the time they finish the interview; they will recognize its value. But as far as telling you where you are going to hear it, that's impossible on our service. One thing they can do, if it's for a feature program, is to tell you the program it's going to be on. But where it's going to be played is impossible to tell on our service.

HOW I COVER SCIENCE: MAGAZINES

Susan West
Earth Sciences Editor
Science News

Dr. Allen L. Hammond
Editor
Science 81

SUSAN WEST

Science News, if you're not familiar with it, is a very small magazine in size, but it has a circulation of about 189,000.

Our audience consists primarily of scientists who are interested in keeping up with fields other than their own. So they are laymen essentially in everything but their own fields. Therefore, we are writing the magazine for a very technically-oriented lay audience--people who already have a high degree of interest in the information we want to present. The magazine has three sections, essentially. The news section consists of spot news stories, breakthroughs, if you want to call them that, although we rarely use that sort of terminology. Then we have brief articles that we call, "Notes," which are interesting pieces on research that we have been following for a long time. Then we run feature stories. Science News is a weekly magazine, which means that, unlike newspapers, we can't present things that happen immediately. We do a second-day treatment of the news. For instance, when Mount St. Helens erupted, it finished its little tantrum right before our deadline, so I had to write that story looking back on it and saying what geologists had learned. We try to take an approach like that.

There are eight writers on the staff, and each of us takes one field of concern. I write about earth sciences, and others write about biology, chemistry, space sciences, physics, behavioral sciences and biomedicine. Most of us have had some sort of science training, although not necessarily in the field we are covering. I have a background in biology and chemistry, but the last time I took earth sciences was in the eighth grade. It varies a lot. Some people have backgrounds in journalism; some don't. Two or three of the writers have been on the staff 10 or 16 years and are real veterans; some, like myself, are not. We exercise a lot of autonomy in what we cover. We each receive stacks of information, stacks of press releases, stacks of journals. We go to various meetings that concern our own fields of interest. I attend the American Geophysical Union Meeting. Each of us decides what is going to go in the magazine, what we want to cover. The editor very rarely assigns a topic. On some occasions he'll pull something out of a newspaper and ask us to follow up on it or do it from a certain angle. But for the most part we exercise our own judgment on these sorts of things. A lot of our information comes from news releases and from public information officers, many of whom have become constant contacts for us, and that's a very

important way of getting information. Unlike some newspapers and magazines, who when they are pressed for a deadline will run a news release verbatim or almost verbatim, we usually use news releases as a springboard. It's very important for us to have clear and accurate information in the news releases. It's important for us to have enough background in that information to be able to evaluate what this scientist or group of scientists has done. Very often it's hard to tell if something is news when we receive it. Our reporters go to a lot of meetings, and we often catch things before the mass media do. So sometimes we'll get a news release six months later about something that we covered a year ago. For instance, recently one of our editors got a news release about some work that Mary Leaky did. The release said she found some footprints and that there were footprints within these and concluded that it was obvious someone had been following this pre-human creature down a path. We had covered that six months before, and it had been released at a National Geographic press conference. But when the event took place wasn't mentioned in the release. It rang a very familiar bell to the editor, so he looked it up and discovered he had written about it several months ago. So it's important to tell us how recently the work was done or if it was released by one or more institutions before. I know that when the National Science Foundation puts out a news release, it says the University of Michigan or some other institution is releasing a simultaneous statement about this. That's really helpful to know because then if it comes across somebody else's desk on the staff or my own, we'll know the background.

The other important thing is finding out who else is working on a project. Very often groups of scientists work together, and this is done increasingly in fields such as earth sciences and space sciences, where projects are costing more and more. We run into problems when we have reports on what one person at one institution is doing because we then offend the 16 other institutions that are working on the same project. So it's good to know what other institutions are doing the same work.

There are also some very mundane things that would help us out quite a bit. Because we often use news releases as springboards, it helps to know where the scientist is, if he or she is going to be on vacation, or if it's possible to have his or her home number, since often we work on West Coast stories as well as East Coast stories. It would even be helpful to have a directory of telephone numbers for many of the scientists and some who could be referred to as experts in their fields.

As I said, because we attend many meetings, these are a major source of information for us. The American Geophysical Union meeting had about 4,000 scientists in attendance. It was an enormous meeting. There were hundreds of papers presented, and I was the only person from our staff at that week-long meeting. It was very hard to weed out what kind of stories I should be following. So news releases become the primary source of figuring out what's news and what isn't news. If you know that a scientist is going to be at a meeting, it would be helpful if you would send out an advance news release, or make sure that the press room at the meeting is stocked with that kind of thing.

Tip sheets are another thing that I find very useful. I know it's hard to predict what's going to happen in the next year, but if you know of something that's coming up, if you know of good feature ideas or people who are always a good story, a rundown of such items would be helpful. For example, there's a meteorologist at the University of Chicago who is flamboyant, but a very good scientist, and he's a great story anytime. That kind of thing is good to know about. It's nice to know if somebody has the sort of personality that would help out a reporter.

One very important thing--and this is as true for people on my end of it as it is for people on your end of it--is enthusiasm. Very often we'll get news releases that are really dry. They say nothing to us; they don't catch our eye. When it's six o'clock and we've been reading through a whole stack of these things all day, we've got to have something that will spark interest, just as we have to write something that will spark interest for our readers. So you've got to put enthusiasm into your material. You have to make us want to read what you're writing, just as we have to make our audience want to read it.

It's also essential to make certain the scientist knows in advance why a reporter wants to talk with him or her. Often I'll call up a researcher and be through with the interview and say, "Well, I really appreciate it and I'll let you know when this article comes out." Then I discover the scientist had no idea that I'd been interviewing him or her. Many have no idea what an interview is; they don't know what we do with the material we get. Then when we write something, they're so shocked. They thought the interview was just a casual conversation and I was making friends or something. It isn't like that. If you know someone is newsworthy, if you have written a news release about this person and you know he or she hasn't dealt with the media before, it would help them and help us if you would sit down and tell the scientist what is going to happen--"You are going to be barraged with phone calls and people wanting to ask you very dumb questions. Expect to be quoted and be careful about what you say, but make sure that they understand it." Try to make the scientist understand that with magazines and newspapers he or she can't always see a review copy of the article. We work on a two-day deadline and we can't very well send something out to the West Coast to have it approved before we put it in the magazine. Many people do want us to do that.

Question: Are you more interested in a news release than the background?

Answer: I would say no. It's hard for me to generalize these kinds of things because I'm speaking from a Science News perspective. We are interested both in spot news--the kind of things we get in news releases--as well as backgrounders. If we don't use the news release for that immediate piece of news, we'll save it for background, for a feature story.

Question: My feeling has been that when it comes to features I am better off handing a reporter background information and letting him or her write the story as opposed to writing the story myself. I've done it both ways. What is your own preference?

Answer: Yes, in that situation, we are more interested in background information.

Question: Would you prefer that we have local freelancers send you a query?

Answer: No, because our articles are primarily staff written. We get very little material from freelancers. So, no, we would much rather that you go through us.

Question: Your point about the professional meetings is interesting. A lot of writers gather at the American Association for the Advancement of Science meetings. There are also meetings of people in all the other fields. And writers go to meetings. Do you find a lot of other independent media writers at those meetings?

Answer: There are usually some independent writers, but more often staff writers from specific news organizations.

Question: Then would it not be worthwhile for a university to prepare a release? When that investigator goes to the meeting, for one thing, the organization might not be set up to accommodate reporters.

Answer: That's a good point. But it works both ways. It's kind of a self-fulfilling prophecy. If you don't provide information there, if there's no bait, then you're not going to catch any fish. As I mentioned before, the American Geophysical Union is a huge meeting. There's always a very well run press room and there are other press people there, not nearly as many as at the AAAS meeting, of course. But you're doing the specialized publications a disservice if you don't serve those meetings as well. But I really think that if press releases were sent out ahead of time, it would help. Press people make calls all the time to different meetings, even if they are not attending them, and will try to pick up on that kind of thing. But that is a good point; I hadn't thought about that.

Question: Do you prefer news releases, personal letters, or would you rather see the person?

Answer: I would probably rather see a personal letter, but I think that comes down to a question of convenience for you. It's probably easier for you to put out a news release. In terms of getting attention, I don't think it would make any difference.

Question: If and when you get a personal letter, do you always assume that it means you are the only person being offered the story?

Answer: No.

Question: Is the story more appealing if you think you are the only one being approached at that moment?

Answer: Personally, I don't think so. It's sort of flattering in a way, but I don't think I would give it any different sort of evaluation if it were a personal letter.

Question: Most of what goes on in universities is basic research and a lot of that is very difficult to communicate and talk about and put into context. It's been my impression that many university public information officers drift in the direction of the things that can be seen more easily, understood more readily, applied to practical public problems, and so on. How receptive are you to ideas about the very tough stuff, quantum chemistry, mathematical subjects, things of that sort?

Answer: That's a good point. We are very interested in those kinds of topics. As I said, our audience is composed primarily of scientists, and they really do want to get into the nuts and bolts kind of stuff. Often the news releases we get are sort of pabulum for us--either we've seen the stuff before, or it is so extremely watered down that we would have to really scale up in a way to reach our readers. The only way to overcome that is to attach some kind of background information, either a paper that the scientist has written, or something like that. But, yes, we are interested in basic research.

Question: How do you decide what to write about for this audience of intelligent people who are not knowledgeable in a certain field?

Answer: I think it mostly takes developing some sort of expertise and that's why we go to a lot of meetings. Then you can figure out what the scientists in that field are excited about, and whatever they are excited about has got to be the best stuff. So that's what you start writing about, and the longer you keep writing, the more you'll learn. I've been writing at the magazine for about two-and-a-half years now. The first year, looking back on it, I missed a lot of really significant stories because I hadn't been covering the field. But the more meetings you go to, the more you get to know the people, and the more it just becomes obvious what the important stories are.

Question: You cover earth sciences; what are these scientists interested in?

Answer: A lot of them are interested in biology. They are fascinated by recombinant DNA articles. Geologists tend to be open minded; they are really dealing with the whole world. Some of them are dealing only with one strata or sediment, but a lot of them are fascinated with ideas about biology and how that fits in with geology and with space sciences.

Question: How broad is your definition of science? Does it extend to policy areas and the social sciences and are you strongly interested in materials of that kind?

Answer: Yes, definitely. I think it's very difficult to separate the two these days. There's always a policy side to just about any story.

Question: Do you think that your audiences are interested in seeing longer articles in Science News?

Answer: Apparently, they're not. We just did a readership survey that shows that most of them are interested in a brief publication, and that's why we stay at 16 pages. People really like to be able to read it in an hour-and-a-half. And they want to know within that time what has happened of importance in science. Who did what experiments and where? Part of the reason we get a lot of material from journals is that scientists don't have the time to read all the journals they are supposed to read. So they see something in our magazine and then they go back and read it in the journal.

Question: How do you distinguish yourself from the burgeoning new crop of magazines?

Answer: Science News is different because of its size and I think because we define science as news; we believe it can be treated as news. I think that makes the difference. Despite what Discover says, it is not a news magazine in science. It can't be because it's a monthly. I'm not trying to put anybody down; I'm just trying to make a distinction between the magazines. Discover's latest deadline is two weeks before publication of the magazine; ours is two days. Of course, when we mail it out, people don't get it until later. But we are probably the most current scientific magazine that's going out and also the shortest, and people want to read something like that very quickly and be done with it. Science 81, on the other hand, is very features-oriented and really well done, as far as I'm concerned. It has more in-depth articles that are of general interest. Even our feature articles tend to get very nutsy-boltsy; they sometimes get very dry, sometimes very technical. Not so with Science 81. Scientific American gets very technical and you'd generally read that for information and use it as a reference. Science Digest to me is like Discover. It tends to do pretty much the same things. And again, what distinguishes us is that we're weekly and news-oriented.

Question: How do you select your lead news article of the week?

Answer: There are a couple of ways. If it's a real toss-up between what is the most important story scientifically or the most exciting, we choose the one that is timeliest, the one that has been presented, for instance, at a meeting just two days before, or the one that comes from a news conference. Our deadline is on Tuesday. If it came from a news conference on Monday, that one would get precedence. That's also somewhat up to the editor. He tends to go with hard sciences for the lead story, rather than behavioral sciences or softer sciences.

ALLEN HAMMOND

At Science 81, our particular perspective and approach to covering science affects the mechanics and the details of what we do and, therefore, affects the way we interact with people like you. Any publication that wants to survive has to respect its audience and respond to the needs of that audience. We're seeking a very broad audience, and that affects what we think is interesting and how we treat it.

Science has largely been an invisible part of our culture, but a very major one. There are close to two million people professionally involved in science and engineering in this country, and I'm not talking about support staffs or people like us. That's a huge number relative to the amount of information that's available, relative to the journalistic coverage of the subject. Professional sports, which occupies a much smaller number of people, is much more visible. And science is a more important part of our culture because it transforms the culture; it changes the direction in which we're heading. Our approach to covering science, since we want to reach a very broad audience, is to cover it as a part of our culture--to emphasize the cultural connection and to make it, in effect, a visible part of our culture so that there can be a dialogue between the two cultures.

That affects a lot of what we do. We will cover stories that are important and timely due to that cultural lens in which the science involved might either be somewhat bold or not overwhelming and earth-shattering in its importance. For example, last year we ran a piece, just when the Olympic games were starting to happen, on the last of the Olympic sites to be excavated. Some new information came out of that dig, but I think in fairness one would have to say that the dig itself did not shatter the archeological world. The story did not focus on how earth-shattering those details were. Instead, it proposed an interesting approach--that is, the ancient and noble ideal of the Greek Olympics had nothing to do with commercial huckstering, national posturing, and the general clamor that mark the current Olympics. The answer, of course, is yes, it had everything to do with those things; that's what the Olympics were like. And the data that filled out the premise for the story came partly from the new dig, but also from the classics of literature. People stopped wars to have the Olympics, very much like today. And it sends an important cultural message, if you want to put it that way. The interest in the story was not in the importance of the research. The interest in the story was in what it said to us about ourselves. And so it was not in that sense a hard science story, although the science was perfectly good and hard. But the way we treated it had more to do with our magazine's sense that we are making visible a part of our culture that is not very visible and providing information that is pertinent to people who are not themselves scientists and who do not have any immediate connection with organized science.

That approach affects everything we do. We use a very broad lens to see what science, medicine, and technology are. In fact, one can organize what we do into two broad themes. There is what I would characterize as

the traditional kind of science coverage--the invention of new knowledge, the breakthrough, the experiment. And the second theme is how science affects our readers as consumers or as citizens. That might tend to involve more applied stories, but it can also involve stories such as the one I just mentioned. Your perception of human organizations and societies is very much a part of how you vote. So we try to cover both kinds of stories and go at what we think is interesting with those themes in mind. In general, our point of view is that taking the technical results and translating them into good English is not adequate. The cultural context, the impact of those results on people, is equally important, sometimes more important. The advance of knowledge is so great, with half a million active research scientists all busy doing something, that one cannot possibly cover all of it. We are unabashedly selective because we are a feature magazine, not a news magazine. We are selective with a lens that asks, "Is this important because it changes the shape of knowledge, or is it important because it changes one's perception of the possibilities or the impact of society on ourselves?" That element underlies the selection and editing processes.

Another thing becomes pertinent when you are trying to reach a very broad audience with subjects that most people still regard as a little intimidating, as hard work, and as possibly even dull. We emphasize very good writing and graphics that are as attractive and eye-grabbing as you can manage within the bounds of good taste and accuracy.

About four years ago, when I first started thinking seriously about this magazine, I made it a point to look very carefully at what was published for the general public about science. After monitoring several publications for quite awhile, I concluded the best writing about science was published in The New Yorker and also the Atlantic Monthly. I found that a shocking fact because neither is considered a science magazine. Science is relatively invisible, in fact, when you think of the image of those two magazines. There was no magazine that reached a large segment of the general public and that consistently had the kind of writing that would intrigue and entrap a literate person who has no pretensions of understanding science and is a little terrified of it.

So we have endeavored to create such a magazine, and we do emphasize the writing quality. We would like to aim for the writing and literary quality that has always been associated with The New Yorker and Atlantic Monthly. If one is going to break down the cultural divide that I mentioned, one must take the first step in terms of using the cultural tools, the frame of reference, that our society lives with, and that is not by and large the language, level of background, and framework that informs the scientific community. So we emphasize good writing, and with a basic belief in the market mechanism, we are trying to create a good market for writing about science and attract into it the best writers in the country. Interestingly enough, we're essentially a free-lance magazine. We have a news section that is written in-house; everything else is free-lance. We use a variety of writers. In fact, the door is wide open. But as it turns out, the writers break down into three types. A third of our pieces comes from the community of people who normally call

themselves science writers, journalists specializing about writing about science. About a third comes from scientists--it's not quite a third, but we're trying to encourage more scientists to take an active part in communicating about science. And about a third comes from general journalists or authors who don't write about science very often, but who are excellent writers and perfectly competent to explore a subject in some detail and write a good piece about it. I think our most successful pieces have been from that last group.

Essentially everything we do is commissioned. It's rare that we get a piece over the transom that we like or want. The commissioning process works in two ways. We come up with an idea and find a writer to execute it, or we get queries that alert us to a story possibility, and we try to respond to those quickly. A fraction of those queries that come in are ultimately commissioned and end up as stories in the magazine. We use a written contract, and we pay roughly a 20 percent kill fee of the agreed-upon price, if the article is unacceptable for some reason. Once a piece is in-house, we do a number of things to it. We research everything independently; sometimes that involves referees. It always involves a fact-checking operation. Sometimes it involves outside specialized advice as well. We, in effect, go over every story line by line and try to independently verify all the material in it. We edit stories, when they need help, tightening, or new leads. Sometimes we completely rewrite them. We have a graphics group that works with the author and the sources for the story to create photographic or illustrating treatments that enhance and carry part of the message of the story, as well as attract people into it. And we have a copy editing group that provides some additional polish, worries about style consistency, and, in general, tries to defend the English language and our honor, as it were.

Putting together a feature story is a fairly complicated process and ends up involving at least five staff people, not counting myself. I get involved in all the features as well. This involves the writer, the illustrators or photographers, the sources for the story, and other outside people, if we use referees. All the pieces have to come together and fit. It takes some time to accomplish. Our normal lead time from the time a piece is in-house and accepted until it is in print, if we're pushing it, is a couple of months, which really means three months by the time people see it. To be timely, we have to guess well as to what is going to be timely. Sometimes the lead time is longer than that because frequently a piece comes in that is not acceptable in its present form and we go back to the author and suggest revisions. Actually, some of our best pieces have been ones that came in and were not what we hoped they'd be. We worked on them; we sent them back; and that inspired, challenged, or shamed the writer into doing better. And the final result was better than anything either of us could have done alone.

Our news section is staff written and closes very rapidly. A piece can be initiated on Monday, slide into type on Friday, and go to press on the following Monday. And then there's a two-week production cycle. It takes nearly a week to print the magazine because we're printing about 600,000 now. It takes about two weeks to go through the mail or to truck

it to news stands. So it's about a month from the time we have to close the news section until the time people read it. That's an irreducable minimum. But we can do things on that scale; we can do longer pieces on something close to that scale. We have a "Special Report," which is a feature-length thing that runs in the front of the magazine, and that can close essentially on that scale. It's less ambitious in terms of art. Feature pieces close at least a month earlier simply because of the color separation process required to do high-quality color printing, and one has to go through page layouts and that kind of thing. It's a complicated process because we in effect design every page in the magazine; we don't just lay it down.

The problem with any editorial group is that it gets insular and isolated. There are a number of ways to overcome this. One of the best ways is to have a lot of interaction with people such as public information officers at colleges and universities. We emphasize that our door, our mailbag, and to a lesser extent our phone lines are always open. We would like to hear from people when they think there are things going on that we ought to be aware of and to watch--whether you want to propose specific stories for us to do or you want to alert us to certain developments. There are a lot of people working on different aspects of several fields, and there may be a lot of excitement building. You might want to drop us a note and let us know about these projects. They may tie into something else we have in mind. We might have a project under way and want to include some of the things going on in several institutions. We try to get our senior people out in the field as frequently as possible to get into the raw material. I think that the problem is always one of being aware of what's going on. There is so much going on, and the more we can extend our resources through people like you, the more effective we can be.

Question: How important is exclusivity to you?

Answer: We want first run of everything. What we'll take is sometimes a little different. That is to say, we will not run a story that has run in the same form in another publication.

Question: Even if it has run in a university publication?

Answer: Even if it's strictly a university publication. For one thing, we have copyright problems. We want the copyright to everything we run. If it's been copyrighted by somebody else, we obviously can't run it. The only exception is prepublication book excerpts, where we are in effect borrowing a copyright for one time. That's not to say that something that has appeared in the university publication is not a perfectly good story. We might run it in a modified, different, or redone version. So I'm less concerned about exclusivity in terms of content; in terms of actual copy, yes I have to be. In terms of the story, we, of course, would like to have it first, but realistically there are levels and levels of publications and audiences. For example, it's fairly rare that we have something before our colleagues at Science News do. On the other hand, we reach a different audience and if we refused to run everything that Science News has already covered, we'd have an awfully empty maga-

zine. No, we're not terribly fussy about that. I think it's hard for an editorial group not to feel that it has to beat everybody and have the only original material. Our readers aren't usually the same as any other publication's readers. If it's a good story, our readers should know about it. On the other hand, if the same story or a story on the same subject has already run in Smithsonian, National Geographic, Discover, etc., we're going to be less interested in it.

Question: Is your magazine available in Canada?

Answer: Yes, we have quite a few Canadian subscribers.

Question: Would you describe how you know which stories are successful?

Answer: Editors always operate in the dark, mostly because feedback is always indirect. If people hate the story, you know that; you get lots of that kind of mail. It's pretty rare that you get mail saying something was wonderful. But you have your own instincts to go on, and there's a grapevine that makes you think you have some feel for what's going on. We also have done some formal surveying on nearly every issue so far, partly because ours was a new publication and we wanted to calibrate. We've done phone questionnaires, random samples, out of our subscriber list after people have had the magazine for about a week. We ask them if the magazine was too difficult or too simplistic. Did it meet their expectations? What departments did they like best? What stories did they like best? We use unaided and aided recall and that kind of thing. Out of that we have some sense of which stories played well. There are few surprises, but generally one can say what you put on the cover is going to play well. People are led to what they should read in many ways. Things in the front half of the book play better than things in the back half of the book. But there are some exceptions and some stories that were very popular surprised us. We did one on gravity waves that I thought was a little difficult and a little dry, but it was very popular. We did a story on the return of the wooly mammoth, which had to do with the use of aminio acid tracing to establish a molecular lineage for the mammoth, and which hinted at the interest among some scientists of eventually finding enough intact protein or DNA in frozen mammoth that they could clone one. I wouldn't describe that as one of our more successful stories, but it certainly was one that people found most interesting to read. The cover story of one issue was really a profile of Tuzo Wilson. It was also almost a history of plate tectonics. It happened to be well along when Mount St. Helens blew its stack, so we ran a substantial sidebar about the geophysics of volcanoes, and how that tied into plate tectonics. And the whole package, together with some elaborate graphics showing what goes on underneath Mount St. Helens, was fairly successful. It dealt with a current event; it was reasonably timely; and we had some good photography. It also dealt with a person who was an interesting character and used that person to communicate information about the geophysics of the earth's crust. People seemed to like it, and we have had good feedback on it. The idea for that came from myself and my senior group. We were setting out to commission a

series of profiles of interesting scientists and we looked at them almost by field. We wanted something in each field. It was clear that plate tectonics was a good subject to get at, perhaps through a profile, because there wasn't an awful lot of news to cover and yet we could assume most of our audience wasn't really familiar with the details of plate tectonics. We looked at several people and it seemed clear that the grand old man of the field was the obvious person to profile.

Question: How did you look at the people?

Answer: A profile is a special thing. You can't do a profile that works very well about just anyone, just because that person is a good scientist. You need a certain colorfulness of personality to pin a profile on. At the same time, it has to be somebody who gives you a legitimate way to tell about a field. Our aim in our profiles is to talk about a person and his or her work, the field of science, that person's particular perspective on the field, and how it's evolving. We want to use the profile not primarily as a personality device, but as a way into the science.

Question: Do you call the universities for information?

Answer: No, we don't call universities; we call people. In the senior group, we generally know quite a few leading people in any given field. And within the AAAS we have access to other people who are equally knowledgeable. We also have an advisory board that is helpful in certain fields, so that generally we don't go in blind.

THE GATEKEEPERS: THE INNER CIRCLE IN SCIENCE WRITING

Dr. Sharon Dunwoody
Assistant Professor of Journalism
Ohio State University

Ben Patrusky
Program Chairman
New Horizons of Science
Council for the Advancement of Science Writing
Free-lance Science Writer

Carol Rogers
Head of Public Information
American Association for the
Advancement of Science

SHARON DUNWOODY

My general area of interest is the process of news making. I study journalists primarily because I think that the way journalists reconstruct reality has to be understood if consumers of stories are going to understand and be able to process what they are looking at. I don't subscribe to the notion that news criteria are better left undefined, that there's some kind of generic notion of what's news.

In the latest, most controversial project I did,* I was interested in a couple of factors that I think are involved in the news-making process. One that's very important to me is the notion that organizational factors control what becomes news for journalists. By organizational factors, I mean things that many journalists assume as a matter of course, things they don't even think of when they think about news making--deadlines, competition, the amount of equipment involved in doing one's job.

A second factor I was looking at is the inner club notion, something that you find in specialty writing, not necessarily among general reporters. I was interested in how informal networks operate in news-gathering situations. I think that within the science writing community there is such a thing as an informal network of reporters who work for the prestige media in this country. Many science writers have told me there is an informal network. I characterize this group as writers who work for media that can afford to send them wherever news is breaking, which is something that many newspaper reporters never experience. In the prestige media, for whom science is a national or international beat, there are reporters who have a great deal of autonomy in their work. They spend less time in the newsroom than the average news reporter does, and more time, at least in the past, on the road. They've become

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*"Science Writers at Work," Center for New Communications Research Report No. 7, appears in Section Two of this handbook.

socialized to one another to a much greater extent than you would normally find among reporters. Research in sociology has shown, for example, that most newspaper reporters become heavily socialized within their own newsrooms. Among specialty reporters in general, and particularly among science writers, a great deal of socialization across media organizations takes place. This group is also characterized by a very heavy professional interest in science writing. Perhaps more than any other specialty writers in the country, including political writers and crime reporters, science writers have a very intense interest in how they do their jobs, in how to do them well, and in how to do them better. There is a great deal of introspection within this informal group.

In this particular study, I was interested in seeing how these two major factors interact with one another. I selected an event that reporters annually attend, and I selected it in large part because the reporters present are saddled with heavy organizational constraints. The American Association for the Advancement of Science meeting is a six-day meeting that many members of this informal network cover every year. And most of them come saddled at least with daily deadlines, if not requirements to write two stories a day. What interested me about that particular situation was: Given those heavy organizational requirements, how does an informal network like this affect what becomes news? What affects what the members of the group do when they actually produce news about the meeting?

What I found, in brief, was that these reporters, like any others, are heavily influenced by organizational demands. The best predictor of the way stories ultimately come out turns out to be organizational demands. If a reporter has to produce two stories a day, that reporter will take action to allow those two stories to be produced efficiently. The informal interactions did have an effect at this meeting, but primarily affected the quality of the coverage itself. Members of this inner group essentially acted as resources for each other, which is a very effective way to cover science. In other words, the quality of the information produced was relatively high, given the fact that the reporters could share information while they were at the meeting. For your purposes, I think the study seems to indicate that the AAAS in this particular instance could essentially decide what was news about its own meeting. It could do this by making available certain papers and by setting up press conferences. Reporters, no matter how good they are, arrive on the scene with a lot of organizational constraints. They're going to try to do things efficiently, and in that kind of a situation I think artificial constrictions of reality like press conferences or making some papers more available than other papers go a long way toward determining what's news about a meeting like that.

BEN PATRUSKY

I'm the permanent chairman for the council that puts on a five-day event every year for science reporters. About 50 to 100 reporters attend. It started back at the time when we didn't have science writers, when people

had been assigned to become science writers on papers, and we had to educate them quickly. So we put together a small faculty for five days to cover science. It's sort of a smorgasbord of science. We get people in astronomy, physics, cosmology, and other fields. We try to find individuals who can apprise the science reporters ahead of time of the stories they may cover subsequently. It's a fast education process. In addition, editors are assigning their reporters to cover this program and they expect them to turn out stories. So we try to identify first the areas that are exciting and about to explode. Then we try to find the scientists who can tell the stories. I try to find 16 scientists in every area of science who can tell the stories well, informally, and in an exciting way. The stories that come out of the "New Horizon" sessions are the ones that turn up in publications for the next six or 10 months.

The public information people are the ones who can tell us who their most articulate scientists are, which ones are exciting and doing interesting work. It's sometimes hard for me to find out who they are. The biggest frustration is trying to fill in these 16 slots knowing that someplace there's a terrific scientist who hasn't told his or her story yet. So I hope that learning about this program will motivate the public information officers to contact me if they have any ideas about possible speakers and tell me something about them so I can pursue it further.

I want to emphasize that the program is conceptual. We want people who can talk about an area that's exploding. The stories are not just something you can turn out in a handout. They're exciting. Science reporters are people who care to be excited, who care to be turned on. The science writer is someone who says, "Hey, this is extremely interesting to me." So in my program, I try to get people whom I find personally intoxicating and whom I think the other science writers will find interesting as well.

CAROL ROGERS

How do reporters get their science news, and what role do we play in the process? I'm addressing the subject of gatekeepers because of my role as a gatekeeper, if you will, in the context of the AAAS annual meeting. In that context, within varying parameters, all of us are gatekeepers. Dave Perlman used a term that I feel more comfortable with than the term, "gatekeeper." The term is "guide," which to me suggests making information available, pointing out who's doing what work, where, why it's important, and how it's important. The whole concept of gatekeeping to me is negative. Gates open up to let people in, but they also close up to keep people out. From my own point of view, I'm a bit uncomfortable with that as a concept. I really don't see our role as one of keeping people out, as keeping reporters from getting the information. Rather, I see our role as one of making information easily accessible to the people who need it and want it. The AAAS annual meeting is the largest general scientific meeting in the country. In that context, we attract hundreds of reporters every year. When you figure that there are only about 50 newspapers that have full-time science writers, you might wonder

who in the world these hundreds of people are. Some are science writers. Many are general assignment reporters. Others are reporters for specialty magazines, as well as mass circulation magazines. They may be television people, radio people, wire service people, and the like. So we have the peer group that covers science all the time, as well as a large number of people who are not used to covering science at all.

The meeting covers all scientific disciplines, runs for five days, and has about a thousand speakers, many of them dealing with topics that are of great interest to the public. The question arises, "How do you get a handle on the meeting so that the information that gets out to the public is the most current, the most interesting, and the most important? To assist reporters in this process, we ask speakers for copies of their papers. We write to their public information officers and tell them that a scientist from their institution is going to be speaking. We tell them if they'd like to do a news release on the scientist's paper, we'd be happy to have it available in the newsroom for reporters. We make the papers and news releases available and set up press conferences. Out of a thousand speakers at the meeting, we have about 10 to 15 percent at press conferences over the five-day period. You can see that a considerable filtering process goes on.

The first time I did a AAAS meeting, which was several years ago, I looked at the clippings after the meeting to get a feel for just how well we had done in selecting press conferences. I found that we did very well. In fact, almost every clipping was based on people we had had in press conferences and, in fact, was based on the press conferences themselves. There were some exceptions to that, but by and large the majority of the meeting's coverage could be directly traced to the press conferences. I noticed that phenomenon for about three years, and at first it made me feel really good. Obviously, we were doing something right. We go through a pretty extensive process in-house to make sure that the press conferences are interesting and relevant. Then I began to realize that, in fact, there is something else going on here. Since what most people cover comes out of the press conferences, the converse of that is true--what's not in the press conferences usually doesn't get covered. We modified the selection process, and for the last three years I've been circulating advance copies of the program to a handful of reporters, usually three to five. I ask them to suggest which sessions appear to be most newsworthy. Interestingly, we get a wide divergence of views. The physical science reporters basically want things in the physical sciences, and the biomedical science reporters basically want things in the biomedical sciences. But there are also some that basically validate our initial selections and also point out some things that we missed in the process.

In looking at the coverage of the meetings in the last three years, when we've been going through the process of including science reporters in the selection process of setting up the press conferences, I still see that the majority of the coverage is based on the press conferences. I feel a little more comfortable about it knowing that the journalists themselves have had a hand in deciding what press conferences are going to be conducted. It's not quite that cut and dried because, just as Sharon

Dunwoody said, reporters' decisions about what they cover and how they cover it are based to some extent on external constraints, such as deadlines, how many articles they have to write in a given period of time, and so forth. We, too, have to fit press conferences into a time frame. We have to schedule them just before a session so that, in fact, the information is released at the time of the session and will be considered newsworthy by the reporters and attendants. So there is another filtering process there, too.

I see our role, in terms of providing reporters with information, as being very central to the process of what gets covered. As I looked at the AAAS meeting, I saw it happening there. Some of Sharon's work confirmed that. What Ben says about the Council for the Advancement of Science Writing "New Horizon" sessions on the one hand shows that he has been very successful in finding people who are at the cutting edge of certain areas of science. On the other hand, the meetings have served as a very important guide that reporters can then use. They save them a little legwork. When subjects are on that program, the reporters can feel pretty comfortable that, in fact, these areas are going to be useful and interesting to pursue.

When I look at the science news reported in newspapers in particular (magazines are different because they have different time and deadline constraints), I see it coming from a handful of sources. I see it coming from publications--that is, reporters are writing about something that has been published in Science magazine, The New England Journal of Medicine, the Journal of the American Chemical Society, and so on. I see writers reporting information that has come from meetings such as the AAAS annual meeting, the American Heart Association forum, the American Cancer Society forum. I see them reporting on things that have been covered in press conferences that may have been held by various universities to announce what their researchers have done. Some of the news, although it is not as easily traceable, also comes from the often maligned news release. What I see is that very little science news in newspapers has been generated by the reporters themselves. And I think that puts on us an obligation to make sure that we are providing information responsibly in that regard. Without putting any value judgments on it, I think it does raise some real questions about how the public gets its information about science.

Question: What do you mean by stories that are generated by the reporters themselves?

Rogers: By that I mean stories that originate by the reporters' calling up institutions and taking the initiative to find out what new things are going on, rather than relying on the institutions to call them. I realize reporters have serious time constraints, deadline pressures, and so forth. That's why I feel that our role is really important.

Comment from member of the audience: I see a lot of what you're talking about. Maybe it's because reporters read a lot of papers and magazines. However, I think there are more self-generated stories now than about 10 years ago.

Dunwoody: Bill Stockton said in a session yesterday that up to 50 percent of the stories in The New York Times science section are generated by the reporters.

Rogers: I also think The New York Times is to some extent an exception because it has 10 people covering science. Most newspapers don't have any, or they have one. And that makes a world of difference. The other thing he said that struck me concerned the amount of time that he and the other reporters spend reading news releases. And I couldn't tell whether he was including ideas that came out of those releases in the category of ideas generated by the staff or in the category of those coming from outside sources. It was hard to tell.

Patrusky: The New York Times also wants exclusive stories. So if the public information officer contacts the Times and serves as the conduit, the article still comes from the outside rather than as a result of the Times going out and exploring the corners of laboratories. The problem is that some people think if an article doesn't get into the Times, the subject didn't get covered. That's the attitude that seems to prevail, and I think it's wrong. There are lots of papers out there, and that's where most people get their information. To pay so much attention to The New York Times is, I think, a mistake.

Dunwoody: Also, you must look at news generation at a local level, at the level of smaller cities. In Columbus, Ohio, for example, the two newspapers do not have science writers, and I think the coverage of science in Columbus is characterized primarily by passivity. There's very little generation of information on the part of the newspapers. Battelle, a huge science institute in Columbus, has a public information staff that generates nearly 100 percent of what becomes news about Battelle, either by phoning journalists, by phoning the city desk, or by taking calls from journalists who ask to speak with experts on various topics and have very little familiarity with the organization itself. So I think particularly with media that don't have science writers, the reporting is quite passive.

Question: Are we doing any good by sending press releases to you for the AAAS meeting?

Rogers: In my experience, coverage of a particular item increases exponentially if, one, there's a press conference on it, and, two, if there's a paper on it. Reporters are able to take a little more time to develop the story if there's something written that they can look at. The news release helps to pull highlights out of a 20-page paper. The release lets a reporter know pretty fast whether it's even worth going any further. So, yes, I think a news release serves an important function in that regard--more so for reporters who are not in the core group of science writers who may already know Professor X and his or her work, or for the general assignment reporters, or the science reporters attending their first major meeting who are totally overwhelmed with information.

Question: Dr. Dunwoody, your report seems to say there is pack journalism in science reporting.

Dunwoody: It has been called that. When I started the study, I was more interested in small group interaction--how people who are directly competing with one another interact and deal with very technical information. I tend to view it as coping behavior--how people at a meeting like the AAAS meeting cooperate with one another when faced with an overwhelming amount of information and technical language in a short period of time. I think the notion of pack journalism takes the attitude that it's a lousy way to do journalism. What I find is that there are a lot of benefits in cooperating with one another when covering science because no one reporter can know everything. In a traditional reporting situation, reporters work alone. You've seen press conferences where nobody works together, where the questions are disjointed, and there's little followup. When I have observed experienced science writers at press conferences, that condition doesn't prevail. They essentially work with one another. A question is asked, and then instead of leaving the topic, a related question gets asked. At a certain level, I don't view that as negative. There's a real feeling in traditional journalism that a reporter is a lone wolf and that cooperation, when reporters are supposed to be covering the same thing, is bad. If cooperation makes the story better, I think it's an excellent idea, and I think it has evolved in this group over time because it works well. I've never called it pack journalism because I don't view it in a negative fashion.

Patrusky: Science reporters talk to each other because science is a complicated subject to many of us. And all of us have done stories that have cost us. There is a lot of hype out there. There's also cash out there, as we've seen with the recombinant DNA issue, and also with the pharmaceutical houses out there beating the bushes for publicity. A reporter has to be very careful, and I think all of us covering these things for some time have begun to trust each other a lot. We've all covered certain areas and have our own areas of expertise. So we check with each other. In this sense, I think "pack journalism" is healthy.

Question: What are examples of areas that are exploding?

Patrusky: I think x-ray astronomy is an exploding area in many ways. Calcium protein is also going to be very important in biology. The implications seem extraordinary, and I haven't seen too much of it covered. Social biology is another imminent issue. There's now some evidence enabling a fair assessment of whether there is such a thing. For example, is there a social gene? We must also cover the social issues of science; they have tremendous impact on society. The reporters also need feature stories. There's a pacing involved here. We don't want to keep hitting them with cosmology, so we balance it off with psychology. So part of the program deals with new frontier topics, while part deals with other information that hasn't been covered, with new horizons. I try to identify things that I think are about to happen. I check the journals, I check with my friends and colleagues, and I ask other people who have been on the program in the past. Then

I try to put together a program of topics that are imminent, that the reporters are going to have to cover pretty soon. It's scary for a reporter to go into a press conference on x-ray astronomy and suddenly somebody's giving you all this information. There's always some reporter who knows the particular topic, along with those who don't. That's why there is pack journalism, by the way.

Question: Dr. Dunwoody, in your research, after reporters in the core group share information, do they write the same story?

Dunwoody: As I said, the event I studied was this massive AAAS meeting, and the answer to some extent is yes. There is by no means a one-to-one relationship. Everybody isn't doing exactly the same story. But the reporters are doing many of the same stories. I think this is the topic selection part of this business. And as I said, I think this is governed a great deal at the meeting by organizational constraints. A reporter is going to select something to cover that gives him or her a much greater opportunity to get a story from it. Press conferences are specifically designed for that. Even if reporters like a topic, I think the general tendency is not to attend a symposium, but they will go to a press conference. I think this is also partly a factor of information sharing. If there is a kind of group story, reporters can share information. Some reporters will say that they all independently picked a particular press conference to attend. And to some extent that's true. But I think that the kind of reporting that's done, the deadlines that have to be met, and the need to share information reinforces this action of doing similar stories. Reporters obviously can't share information if they've gone in two different directions. So at a meeting like the AAAS meeting there's more to be gained, not only among this core group of science writers, but among all science reporters, by having group access to information and by writing similar stories. I also argue that this is somewhat related to another organizational constraint that I call competition. I have experienced it in my own newspaper work, and I got reports from individuals that I studied of the same phenomenon. Competition is not a matter of reporter against reporter in a situation where reporters are friends. There is certainly competition in that they work for competing media and feel a sense of responsibility to their media organizations. But at the same time, these reporters are friends. And that's a conflicting position. Also, their editors are monitoring what other newspapers are doing, which is not unique to science writing. What happens is that, if your editor is monitoring another newspaper, he or she believes you've done a good job if you've produced essentially the same story as that newspaper or wire service. And in a number of cases, reporters were called and asked why they didn't do the same story as someone else. There is a tendency toward duplication in these situations to meet this criterion called competition. So there are factors resulting in homogeniety in news making at meetings in which there are a lot of organizational constraints.

Patrusky: I don't totally agree. The AAAS meeting is such a giant meeting that somebody has to do some culling. You've got enormous numbers of reporters and other people there. It would be horrible if

they came into a situation where there were a thousand papers to choose from. How would you select? You need somebody to guide you, and that's what Carol Rogers and her staff try to do. She called herself a guide. I think the organizational constraints analysis implies something negative about quality. And I don't see that. When I directed PR for the American Heart Association for 10 years, I handled a big national conference, in which 500 papers were delivered. I saw my job as a surrogate reporter. I didn't have an ax to grind. I saw myself as being a friend to the science reporters, as someone to help them find a story, not because I had something to convey or to push; that wasn't my job, and I don't think it's any of our jobs. I think our interest is to get information out. The fact that science reporters go to the same press conferences is because Carol has accomplished part of that task, not because AAAS has something it's trying to push.

Dunwoody: I didn't mean to imply that AAAS is trying to maintain that kind of control.

Patrusky: But when you talk about constraints, I'm concerned about control. I didn't hear any other constraints. There were no constraints on me at the American Heart Association; I just tried to identify what I thought would be terrific stories.

Question: What about lobbying and pressure groups?

Patrusky: There is a great deal of lobbying. That's what pharmaceutical companies do when they send you handouts or take a reporter out to eat and try to sell a story. That's the kind of pressure you get.

Question: Dr. Dunwoody, did your study deal with the newsroom constraints that science reporters may experience?

Dunwoody: I didn't go into the newsroom to look at that. The only evidence I had were reports from these people about their autonomy in the newsroom. I think they have more than any other group of reporters. They are in fact their own editors in many cases. Unlike almost any other kind of reporter, science reporters experience few newsroom constraints, partially because editors don't know a great deal about science news writing. Although their backgrounds have been predominantly non-science, these reporters have been on the job for a long time, I think a median of 15 or 16 years. They are highly skilled in many areas of science. They have particular areas in which they have more expertise, but they generally have a great deal of science information. I also think science writers experience less turnover in their jobs. The newspaper field has a very high rate of turnover among professions in general, although the rate is decreasing. But given that, science writers themselves are a very stable group within newspapers. There's very little movement out of science writing compared to other parts of journalism. I get the impression that there is a higher level of satisfaction with the job than among other reporters. Science writers take a great deal more responsibility for what they do than do other reporters. This is because the information is so difficult that other people in the newsroom don't

feel they have the expertise to step in and criticize. I don't know exactly what taboos they run into, but I think they probably run into fewer than the average general assignment journalist does.

Question by Patrusky: Does AAAS have science reporters helping you choose what to include in the press conferences?

Rogers: For the last three years, we have sent the program usually to some officers of the National Association of Science Writers who have expressed a willingness to assist in that way. We have them go through the program and comment from their point of view. We do make the final decisions, but we've been getting their input. I sense by the question that you have a problem with that.

Patrusky: I'm concerned because it seems to me that you have the people who may be covering the events choosing the kind of thing they want to cover.

THE SCIENTIST AS NEWSMAKER

Dr. Rae Goodell
Assistant Professor of Science Writing, MIT

Cristine Russell
Science/Medical Reporter
The Washington Star

RAE GOODELL

In my studies of science communicating, I looked at about 50 visible scientist-celebrities in detail. And I found that these celebrities were, first of all, willing to go public. In spite of their diversity, these scientists have something in common--they are colorful, eccentric people. They are very quotable. They're talking about areas that are controversial or at least have a considerable amount of human interest. These scientists are credible in the sense that they come from solidly established institutions of various kinds. What I immediately observed was that these qualities in scientists are what the media need, not so much the specialized science writers, but the general reporters. General reporters covering science need a lot of help, and they get it from these celebrities. Sometimes they might get too much help. Margaret Mead, out of frustration when a reporter was inept, would sometimes just write the story herself and say, "Here. That's what you're supposed to say." I'm not disturbed by the reasonable amounts of help that these scientists give to general reporters. In your universities, however, there is a fair amount of consternation about these scientists, and a fair amount of not very nice things are said about them. I'd like to address some of the criticisms and some possible responses to them.

One of the first criticisms is that those scientists are speaking outside their areas of expertise. As Jean Mayer suggested in an earlier session, one needs scientists who are out of their areas of expertise in the narrow sense, who are willing to talk about more than their immediate research area and to give us a perspective on a whole area of science or science policies. One can go too far, of course. The question of what is too far is a matter of judgment, and will depend upon your assessment of public need and the wishes of the scientific community and your administrators. In addition, I think one has to realize that these celebrities, particularly if they are eccentric and colorful, are still only human. It's obvious that they have prejudices. That's not nearly as harmful, I think, as the kind of scientist who appears very straight, who appears to be talking in his or her narrow area, such as a nuclear physicist talking about nuclear power and appearing to be simply giving the facts. In a way that's more misleading than the scientist who is talking flamboyantly about a broad area and is stimulating, but clearly opinionated.

A second criticism is that these scientists aren't scientists at all--they are just popular artists; they're not doing any serious research. I looked at the question of the research of these scientists, and, with

a few exceptions, I couldn't find any serious criticism of the research of these scientists within their areas. Some of their research was controversial, but it did have a solid following and was considered a solid contribution to the particular research area. A more important question, in my opinion is, "So what?" Clearly, one doesn't want quacks communicating science, but do the public scientists have to be actively doing research? Is that really a necessary connection? Or, do we perhaps need a special role for these scientists in the universities to give them some status and recognition? Should the popularization of science in itself be considered a contribution? Dr. Mayer also pointed out that American society tends to emphasize data collecting and number crunching. What about the theorists? Linus Pauling has always been a theorist. Carl Sagan is somewhat of a theorist, too. Other scientists tend to say, "But that's just a theory." And they fail to acknowledge the importance of theory.

Another criticism we hear is that these scientists are bad for the public image of science. They're creating the wrong impression of science. They're being very human and biased. They're not being precise, and this is bad for science's image. I suggest that, on the contrary, it's very good for the image of science. In the long run, a more honest vision of science within the public will help the public have a clearer understanding of the whole of science. A perspective of science's human side as well as it's data-collecting side will in the long run create less misunderstanding between science and the public. As a result, there will be more support for science than can be generated with the kind of image-making that scientists are striving for--that effort to project always a positive image. That's Madison Avenue, and I think it causes distrust on the part of the public. A much more honest image of science would have a better effect.

I'm suggesting that these are some other ways of looking at these public scientists. I'm not saying that they all are right or that there are not enough of them. But I suggest that perhaps they do play a positive role in the communication of science.

CRISTINE RUSSELL

I'm looking at this topic from a slightly different perspective. As a daily science journalist, I'm regularly faced with this problem: preparing a story, and then getting my newspaper to pay attention to the story so that it doesn't end up buried on page D-14 or behind the classifieds. When I'm covering a scientific topic, I'm also considering who is making this news or where it's coming from. Obviously these visible scientists attract attention and help convince our editors to get the stories in the newspaper. Like other journalists, I'm afraid that we are often stampeded into staged events or press conferences, particularly if someone does have a prestigious name or has won a Nobel Prize. But these are the exceptions.

There are two groups of scientists that we deal with traditionally. We have the more reluctant scientists, the ones who hate the press, who

think they're going to be misquoted, who immediately start talking in the most technical language possible, who grimace if you ask for any prediction of when their work will actually have some practical value. I was at a meeting at Stanford on artificial intelligence recently. The scientists involved had apparently been burned by the press several years ago, and they seemed to have made an informal pact among themselves never to say another thing in plain English to a journalist. We literally had to follow some of these people around; we had called their offices and been told that they did not want to speak to the press, that they had no comment. Yet their research was being funded by the public, by the National Institutes of Health. They were at that one extreme of not being willing to talk.

Increasingly, we have to deal with the other extreme of the visible scientist, the newsmaker, the person who is willing to talk. Within this group we do have some glib, big-name scientists who are attractive to journalists, especially those who are not science writers. I happen to think that because they are so quotable and have developed this remarkable ability to speak in English to large audiences, they do get quoted too much. It is sometimes hard to avoid that. I think that in some ways Carl Sagan, within the scientific community, has overexposed himself. But he also in a sense has changed his role. He has now perhaps jumped across to our side of the fence as a TV celebrity. At the moment he's much more a journalist than a scientist. I know some other scientists who talk as well as Carl Sagan does but, because of pressures they have felt within their particular area of science, have consciously tried to back off from their public roles. They've made a decision not to attend press conferences this year because they've been getting vibrations from their colleagues that they are too public, that they are speaking too often, and that they are not scientific enough. It's unfortunate when a scientist who has something to say feels pressure within the scientific community not to talk. I think somewhere there is a happy medium.

A problem arises when some of these big names do go out of their areas of expertise into less orthodox areas of science. Knowing how to deal with Linus Pauling and his research is always a problem, but he is always showing up. And he will usually find someone who's going to be attracted to write something about his vitamin C research.

As science journalists, we have to be careful not to write off this kind of research just because some of Pauling's colleagues are skeptical. Somehow we have to find the middle road in dealing with these less orthodox areas in which big names can attract attention.

More recently we've had much more of a problem with scientists and their causes. Again, the idea that scientists are neutral and objective is appealing, but obviously not true. Increasingly, scientists have been willing to step outside of their supposedly neutral role, particularly on scientific issues. Often, particularly in Washington, we're faced with scientists on both sides of the fence. And it seems on almost any issue these days you can get someone to say something on either side.

The saccharin debate, for example, was a constant source of difficulty in terms of whether saccharin posed a health risk to anyone besides the mice that drank 800 bottles of pop. But each side, whether it was the Calorie Control Council backed by the industry or the consumer groups, could bring forth its own studies and experts on the topic.

When we're faced with experts who are involved in special interests or causes, journalists have to sort that out. Let's take an extreme example, such as Barry Commoner, who over the last several years has increasingly stepped outside his role as a scientist and more into his role as an activist. It's our responsibility as journalists to point out to our readers not only his scientific credentials, but his current role in a particular organization or political movement. We have to help our readers distinguish between the scientist as activist and the scientist reporting scientific research.

Also, I often receive calls from obscure scientists who want to be news-makers, but no one has ever heard of them. Again, I don't want to be in the position of just writing off everyone who does not come from Harvard. But sometimes it's very difficult to know how to deal with these people who call up, particularly if they say they have this great research that the journals are ignoring. There's a tendency to make the assumption that what they are talking about is not acceptable, but I never say, "Don't call me." I ask them to send it, and I try to find out whether what they're saying is sound. Again, we don't want to control the news or control what the public is going to hear to the extent that it doesn't get anything new or anything outside of the orthodox channels. In covering areas such as the laetrile debate, it's important for us to distinguish whom we're talking to and to check and see who is helping or funding the scientist in his or her work. If someone won't tell me who's funding the research, then I'm a little suspicious.

In the last couple of years, I've encountered another problem: scientists or their institutions who are trying to sell us stories because they're interested in funding for their project. The Washington newspapers are particularly attractive for this because the people promoting the story assume that members of Congress and NIH officials will see it in the newspaper. Sometimes it's only by accident that you find out the scientist's grant proposal is awaiting approval or is up for renewal. That doesn't mean we're not going to do the story about that research, but, again, it's often helpful to know someone's motive for pushing a story.

We get dozens of calls every day from very fancy publicity agents or firms representing scientists. Many scientists have discovered this great journalism market and are writing books on health or science. I probably get three or four calls a day from some publicity agent who is setting up a national tour for a doctor. Often it's hard to figure out whether that doctor is really saying something new. But the doctor is probably going to pick up a lot of attention around the country just because he or she has a very effective agent. I think this is a change for scientists, and more of them are willing to be "sold" in this way.

I'm not saying that in a negative way, but there's just a lot more promotion going on.

As a result of all the pressure we get, we're naturally skeptical, and we have to be. We have to watch out for the particularly shrill voices we are encountering. And sometimes we have to dare to ignore those with big names but with little to say at a particular time. We have to determine if something is really a news story or an interesting feature story and not just cover things pro forma because someone is offering the story or because he or she has the right credentials. We must often go back and check with the experts in the field to find out whether something being promoted is a legitimate advance.

Question: We have had visible scientists on our campus and they have gone back behind their doors. They saw their research turned completely topsy-turvy by a national television network and as a result want no more contact with the media. I can continue to get through the door because I have worked with them in the past. And I find it difficult to explain to them that the national media did that once, but they probably won't do it again. How can I be an effective liaison between the media and scientists under these circumstances?

Russell: That's difficult. Without saying something negative about my colleagues or anyone in the press, I think it should be explained that there is a difference between people covering science full time and people on general assignment who may dip into any area of expertise at any moment. Sometimes for the particularly reluctant scientists, it's helpful to explain the credentials of the person seeking the interview and maybe even to provide some examples of the science writer's work. I'm always happy to provide that if somebody is being particularly reluctant. I'm not going to defend every journalist, and your scientist is not going to defend every scientist. We're all sort of independent practitioners, and I don't want every other journalist to have the story, anyway; I'd rather have it myself. The reluctant scientists are probably not going to volunteer to have a press conference at your institution. But maybe on a one-to-one basis with a science writer they can get some understanding of the way the writer has covered things in the past and can set some ground rules during the interview. We're often willing to agree to things, but the ground rules must be clear. Again, there are different approaches to covering any story, and I think you just have to deal with reporters on a case-by-case basis.

Sometimes, however, I think this fear is a kind of phony excuse by some scientists who are reluctant to take the time to deal with the press. They'd rather have the public affairs office tell the story, write a very nice press release, and deal with the press. I'm very reluctant as a science writer to deal with it that way. I love to get the fantastic press release. I love to deal with the public information officer on the story, but I'm generally not going to write the story unless I can talk to the scientist. Very few of us would do anything based purely on paper. I don't get the New England Journal of Medicine and write a story directly from that without talking to the person, unless it's something I've

written 50 stories on and I know every wrinkle of it. So it seems very strange to get a press release and then call up to learn this scientist won't talk to anybody, that having gone half way he or she suddenly wants to pull back. Maybe other people will operate on that basis. But I think it's unfair for that scientist not to subject his or her work to the scrutiny of the science writer.

Goodell: You might also point out to these scientists that their refusal to talk to reporters because of one bad experience is really sloppy thinking. If they were to do an experiment that didn't work out, it wouldn't stop them from ever doing research again. Suppose they were to publish something in a technical publication and have it plagiarized. I doubt that even a traumatic experience like that would cause them not to publish a technical paper again. So in a sense they're inconsistent in their reasoning that a bad experience with the press justifies never interacting with the press again. On the contrary, in most cases, when you have had a bad experience you learn from it and know how to handle that situation better the next time.

Question: In this particular situation with the network, was the problem brought to the network's attention, and what were the results?

Answer from audience: The network was very unsympathetic. The network had fabricated some scenes that it thought applied to this gentleman's research, but which in fact did not, and the implication was serious. The network did not apologize and said nothing could or would be done about it. I will continue to work with the network, but I will always have in the back of my mind this particular producer. It's going to be very hard for me to help him gain access in the future to any other scientists or our institution.

Question: Do scientists ever ask you to read back a story or send copy for approval? If they do, how do you handle that?

Russell: With people who have not dealt with the press before there is a universal attempt to check the story, and I'm sure if I were in their position I would ask the same question. I always respond that I can't send them the article for approval. I say, "No, I would get fired if I gave someone that I interviewed the right of scrutinizing the article and deciding whether or not this was indeed the way the story should run." There's too much danger in even trying to play that game. I think that scientists somehow want to do it much more than others do. I've never had any problems explaining this. It usually comes up ahead of time. I will occasionally call back and read the scientist specific quotes and say I am checking them for accuracy. I don't mind checking things for accuracy, but usually time doesn't allow us to get a story back to somebody and have him or her read it. A daily newspaper literally is coming out daily. If I'm doing a long story or something where I have time, I'm going to check back. But usually I have a tape recorder and I've never had anybody say their quotes were inaccurate. That reluctance is usually expressed at the beginning of the interview. If the interview has gone well and the scientist has some sense that the reporter

understands what he or she is talking about, and if the reporter is asking reasonable questions, the scientist seems less nervous at the end of the interview and less insistent that he or she has to check the story. Scientists have to understand that we're professionals, too, and that we have no desire to write a story that's inaccurate or misleading. Once they've agreed to the interview and once they understand the journalistic ground rules, there is less of a problem. I just don't know of any science writer, particularly in daily journalism, who would send a story back and give the scientist veto power. But we would check for accuracy, and I always say I will call a source if I have the slightest question. Sometimes people won't agree to be interviewed on the record. They might want a purely background interview, and I might agree to that. Then if there is something that I particularly want to quote, I would call and say, "I want to quote this sentence; do you have any objections to that?" So we just have to work that out without violating our professional ethics or ground rules.

Comment from audience: There seems to be a range of answers to that question. They vary all the way from, "No, I won't check a word with a scientist," to, "Yes, I will check quotes and anything that's directly attributable to the scientist." There seems to be a variety of ways people handle that problem and no one particular way of solving it.

Russell: I don't think anybody would send anyone a story and say, "O.K., go to it." It's such a temptation. Once a person gets the story, he or she is going to start tinkering with it. I don't think it's a problem unless someone is not candid with the person being interviewed to start with. And if the scientist is nervous, the reporter has to be very specific about the ground rules. It's very frustrating if, after a reporter has been there an hour, the scientist says, "O.K., I won't let you use my name unless . . . ." That happens, too. Some people are naive, and others are just trying to manipulate the journalist. I think we just have to try to work it out as best we can without totally giving away all of our rights as journalists.

Question: Does everything have to go through the entire scientific review process and be generalized by the professional journal before it's ready to be public information? Isn't it all right to write a story about Linus Pauling's ideas on vitamin C provided you've set them in the context that shows the ideas have not been experimently demonstrated?

Russell: A lot of what we cover is controversial, and I don't try to simply write about issues that everyone has already agreed upon. That would be rather boring for our readers. Again, I would never write a story about Linus Pauling's vitamin C experiments or whatever without some commentary from other experts. We don't want to dismiss these people out of hand, but we want to be fair and present the evidence and the reaction. I think we can do that and be fair to both sides and also be fair to the readers by giving them some perspective on where the uncertainty lies. Unfortunately, as my editors are always saying, all I ever write are stories where I lay out the facts on the one hand and on the other hand, and where the experts don't agree. Most of my time

seems to be spent on problems for which there is no one scientific answer.

Question: How did you handle the Steve McQueen cancer story?

Russell: I didn't handle that. On various cancer treatments and drug treatments in general I have a very conservative approach. I don't do very much with them unless the treatment is getting to be so pervasive or unless so many people are concerned about it that I have to put it in context. There are so many new cures and drugs. There are so many dangers in writing about these things before they have been proven that I try to stay away from treatment stories unless there have been serious scientific trials. I always think of the readers, and people take those stories very seriously.

Question: Do you get a lot of pressure from your editors to do a story just because your competition is doing it?

Russell: We're all very competitive so that's always a problem. I'm always unhappy when I feel I'm being manipulated into doing something for that reason. In general, I think we're very lucky in the science area. In my case the competition is The Washington Post, and we usually both have the big stories. Because ours is an afternoon newspaper I get a certain number of calls at 11 o'clock at night after the first edition of the Post has come out. If the Post has an important science story that I know something about, I may try to match a story and do it at midnight that night and get it in our newspaper. But a lot of other stories the Post may have are just feature stories of interest, and we may not have them. I have more flexibility because our editors don't know that much about science. In general, I think science writers are self generators of stories. I get very few suggestions of stories. The reporters who cover politics and other beats in Washington have to be more concerned about having a story when the competition has it. I have less of that pressure. The flip side of the situation is that sometimes the editors think science and medicine stories are not as important as what's happening at the State Department. But on the very big science news stories I hope I will not be so out of it that I don't have a story the competition has. If it's something that I should have had, then I will try to get it. But I don't like to match stories. It's not fun to be following in someone's footsteps in trying to track down a story.

Question: If you are called to a press conference, do you routinely go?

Russell: It depends on what the press conference is about. We are called to so many conferences that if I went routinely, all I would be doing is going to press conferences. Washington is really a city of staged events, and there's always that kind of manipulation. In a sense it's very helpful to us. That's a very easy way to cover any beat. If the subject is important, I'll go to the press conference. Sometimes we are misled by people giving us the information about the story, and so we again have to judge whether everyone's going to be there. I cover the Depart-

ment of Health and Human Services. So every time the Secretary has a press conference, I show up. If I don't, I'm going to miss something. But there are numerous other press conferences that I might or might not attend, depending on the subject matter and my own judgment. And there are lots of tricks. I was invited to a press conference recently, but the organizers initially wouldn't tell me who was going to be there. They didn't want to reveal the name of the person because they were afraid we would call this person. There was so much mystery involved. Well, I did show up, but only after I had found out the name of the person and also written the story in advance to fit in with our deadlines as well as their embargo. Because I'm on the afternoon newspaper, I have to work either forwards or backwards much of the time. For competitive purposes I try to get today's news in the newspaper today. I usually am interested in press conferences, but usually may have already written a story by the time I get to the press conference.

Question: Dr. Goodell, I'm curious about your job at MIT. What do you teach?

Goodell: I teach elective courses in writing for the mass media that students take usually for fun. There are also technical writing courses, which are probably less fun. The courses I teach are for students who think that they might want to try writing for the mass media as scientists and engineers, or who at least want to know how to talk to a reporter intelligently. In addition, MIT is developing a master's degree program for people who want to become professional science writers, for students with backgrounds in science or engineering who might want to use that background for a career in writing instead of a career in research. It's experimental; we're just trying it to see how it works.

Question: What kind of interest in the program is being shown?

Goodell: There has been a lot of interest in the graduate program. I think there are a lot of disaffected science and engineering undergraduates who are thinking that they'd rather become writers than researchers. I'm not at all sure they won't be equally disillusioned when they find out what journalism is like. But there has been more interest than I might have expected in the graduate program. There's also interest in the undergraduate courses. There are students who think it's fun to learn about science writing.

THE GENUINE ARTICLE: REPORTING REAL RESEARCH

Warren Leary
Science Writer
Associated Press

Susan West
Earth Sciences Editor
Science News

Patrick Young
Science Writer
Newhouse News Service

PATRICK YOUNG

Every reporter wants to get published as much as possible. In the newspaper chain I work for, I want to get published in more than four or five newspapers, which is about my average, out of a chain of about 28 papers. So there is always pressure to report on stories that we feel are going to get some type of play. I do some stories just because I want to do them. I figure that for once I'm going to do some "real science"--and then these stories end up getting much better play than some of the things, such as medical stories, that I thought would get phenomenal play. So there is that problem.

The bigger problem, however, is trying to explain adequately, accurately, and interestingly a complex technical subject in 900, 1,000, or 1,200 words. It's a very difficult thing to do. If we're trying to explain, for example, the various research techniques used in high-energy physics, we really can get bogged down. So, frankly, I tend to limit the number of stories involving a great deal of complexity. I prefer to talk about what's been found and explain the significance of it because that's what I can do best in 800 or 1,200 words. And if it's the type of story in which I have to explain the technique itself, the chances are good that it won't be written for Newhouse. It's not a situation I'm particularly happy with, but I think I do a better service to readers if they can walk away from a story understanding it rather than being confused. The other problem is that if the editors get confused by a story, they're not going to run the piece.

Regarding the selection of stories, we all have our favorites, and we tend to write a little more about subjects we favor. There are also stories that tend to be more interesting to people. The truth is, if we have a choice between dinosaurs and clams, dinosaurs are going to win hands down every time.

SUSAN WEST

I agree that Science News also covers basic research, real science, or however you want to phrase it. We're obliged to cover basic research

because our audience is primarily scientists. But our readers still have to be interested in the story. They still have to be motivated to read the story. They won't just read charts and sets of data. If they did that, then they'd just go to the journals instead of reading our publication. And in that sense, we don't pick stories just because we want to cover them. Each writer certainly has areas that he or she prefers, but we're also obligated to get out the major news in that field and to thoroughly explain the major developments, no matter how boring they are to us. Sometimes, as far as I was concerned, I've written some really boring stories, but the scientists wanted to read them. It was their way of getting information.

A lot of Science News readers are other science writers who aim for more general audiences. So we are sort of an intermediate between the jargon of the journals and what the general publications have to come out with. We have to have all the pieces there; we can't leave out as many pieces as a lot of other people do. We do that with varying degrees of success, of course, as everybody does. But we try to make things relevant, to explain them in context, such as why a housewife would care about quantum mechanics, and so on. It gets very difficult. Sometimes you have to have an intrinsic interest in that subject, and sometimes there's no way of making something really sexy. We had an article recently about a mathematical subject. It was well-written, but it was very dense and difficult. The content was so difficult to understand that there was no way the writer could have broken it down any further. So you had to be interested in that in order to read it. I think we do cover real science, and we try to do it in a readable way.

WARREN LEARY

At the Associated Press, we don't even pretend to cover basic science as much as we should, and I'm not even sure we have that obligation. We have to look at our audience, our time constraints, and our space restraints. I don't frequently have 900 or 1,200 words to explain something in a story. I might have 400 or 500 words. There might be a story that interests me, but there may be no way I can write it. For example, I recently saw a story in Science about prime numbers. I thought it was interesting and passed it around to some people in the office. But I realized I couldn't write mathematics stories for the general audience. My readership is a general audience, served by 1,300 papers in this country and 3,500 radio and TV stations. Anything I write has to be in some way condensed for broadcast, also. If I can't cover a subject in 500 words for a newspaper, I certainly can't condense it to 100 words for a broadcast story. So some topics I have to leave alone. Of course, certain areas are of special interest to me, and every once in awhile I'll take a chance and try to write a basic research story in this particular area--with me it's subatomic physics, which I particularly like. I know that story is not going to appear in a lot of papers, but I write it and ship it out. And sometimes I'm surprised because a paper will pick up this obscure story. Sometimes I want to go on record as having written a story, even though sometimes I can't even explain what

the story is about. The discovery of the third quark was one of these. I wrote a story about that and in it I had to tell the reader, in essence, "You probably won't understand what this is about, but it is really important. I'm going to give you 400 words of physicists saying it's really important, but I really can't tell you what they did." We write these and ship them out and hope that there's someone interested enough in the subject to pursue it in a science magazine and get some more details on it.

There are also stories that we as writers may like, but that readers don't particularly care for. We usually have a sense of what readers like. They like archeology stories and astronomy stories to a certain extent. So we try to find an interesting way to relate what we're writing about to something the reader might understand. If we're writing about high energy astronomy, which is not as sexy as writing about visible astronomy, and we don't have a picture to go with it, we have to figure out some way to relate that with this visible astronomy that the reader can understand. I don't think there's an active aversion to writing about basic, or real, science. It's just very difficult to do within the constraints of our work. If we can find a way to do it, we try. Sometimes we get good help from talented scientists who are thinking about what they are doing and can actually explain it. If that particular scientist has a certain gift for explaining what he or she is doing and its implications, that's a help. Sometimes just having that help will allow you to write about this basic research. To some extent, public information officers can help identify those people at their institutions. There are not a lot of Carl Sagans around who can explain things like that. Every once in awhile there is a scientist who can go home from the lab at night and very simply and reasonably explain to her husband what she's been doing all day. Or the scientist who comes home and a kid jumps up in his lap and says, "Gee, Daddy, what happened today?" And he can explain what this molecule he's building really means. If you can help us identify people who can explain basic research in a way that is palatable and interesting to the public, that would be a big help.

Young: That's a key point. A technique I use is to tell the scientist to pretend I'm a one-man Rotary Club and to explain his or her work. Sometimes it really ignites; sometimes there's this look of horror. I also have a rule of thumb that I rarely violate anymore--I don't like to do stories on anything smaller than a molecule, or at least an atom. I have had some very frustrating experiences with people trying to explain to me some of the things that go on inside atoms. They were trying very hard and I was trying very hard, and it just wasn't coming across. The role of the information officer in this case can be very helpful. At NIH, for example, the information officers have their key dog and pony show members. "Do you want to talk about aging and the cell? Well, we've got Dr. So and So at one of our labs." They're very good at getting somebody who can just explain the mechanisms involved. When I'm doing something on fairly basic work in seismology I like to touch base with Don Anderson out at Cal Tech, for instance. There are a couple of astronomers and scientists in various fields whom I like to just check with occasionally on what's new and what's significant.

West: I think it's a fallacy to think that the general public isn't interested in just the goings-on of science. I think they really are. I think this whole growth of science magazines, science sections, and science stories that the newspapers are picking up these days shows that. But we have problems with editors who don't believe that people are interested in that kind of story. When I was working on a newspaper, the editors would cut any science story down to 500 words. They didn't believe there was anything important enough in science that couldn't be said in 500 words. And they didn't want a story to explain how scientists work, how they carry out the process of science. I think a lot of people really are interested in that. That's another place where public information officers can help. If you can obtain more of the nuts and bolts and present it in an intelligible way, it would help us to get more of that into our stories. It would also help overcome the attitude that people don't really want to know the background, how many times this scientist mixed the solution in the test tube, and so on. A lot of people are interested.

Question: One of the things really missing in a lot of science writing is the lengthier interview or profile of what scientists are doing. For example, recombinant DNA as a topic is really important. Can you sell that kind of story?

Leary: Rarely. There are times when I can do a longer piece, talk about what scientists are doing, and construct the process for the reader. It's a big challenge to be a science writer. Let's say I have 1,500 words, which for me is a lot of space, and I'm trying to construct a process. I have to explain what plasma is, what enzymes are, and what they're doing. And I can get bogged down in trying to explain something like this. So it makes a writer become more creative in finding ways to do it. I've succeeded in some cases and failed in others. Genetics is an area I have difficulty writing about. A number of years ago when I was starting out in science writing, I saw a front page story in The New York Times by Walter Sullivan about some great discovery in genetics, and it jumped inside to almost half a page. It just went on and on with all these little diagrams. The text of the story was talking about little firemen running with ladders, taking them off this building and running to the next building and putting them up. I went through the article and didn't understand it, so I read it again. I think he did everything humanly possible to try to explain this story. Yet I still didn't understand it and I figured it must be important because it was there. I became convinced then that there are some stories we just can't write at that time. Maybe later something will happen; a writer will become more talented or will find someone who can explain it a little better so this sequence of thoughts can be put together in a way that's understandable to the general public. I get annoyed receiving certain news releases about studies being done. I'll get a two-page news release and I'll really want to see the paper or presentation it refers to so I can get some details out of it. So I have to call somebody and have it mailed, and that slows me down. If you're writing a release about a major piece of work being published in a journal or if someone is presenting it at a meeting, put the original paper or the text of the talk with the release. That allows me to perhaps get

more detail and gives me a source document from which to work. Often when I call other scientists for comments they'll say they haven't seen the paper so they can't comment on it. If I have the paper, I can read them a few sections from it and put it in a certain context. Then perhaps they can comment. That is a big help. That helps us get stories from releases.

Question: Do we have to learn to deal with people who specialize in science writing differently than we do with general assignment newspaper writers and editors?

Young: As I've said, you're in a position similar to that of a free lance writer. If you're really serious about getting something in the "big time," if you're talking about trying to get something on the AP wire or in Science News, Science 81, Science Digest, or even the Newhouse chain or the The Washington Post, you really have to know your market. You've got to know what they're publishing and what approaches they're taking. We think of ourselves as news writers, but I'm not a news writer. If a story isn't exclusive, if I don't get it first, there's no chance, with the attitude of my bureau chief, I'm going to do it. So I'm going to do the trend stories, the followups that appear weeks later. Science magazines are all different. There are slight variations that you should start to pick up. If you're serious about publicizing your institutions, you're going to have to start reading the publications, get to know the writers, and figure out how to pitch. And some stories are always going to be much more interesting than others.

Leary: You have to learn what each writer wants and what someone else doesn't. I've been in Washington for about five years now, and I pretty well have my people here trained. They know what I want. They'll send a news release and because they know I always want to be able to get to a researcher in some way, they write the researcher's office telephone number on the top and maybe the home number. If possible, they'll include the paper that goes with the release. They know I'll be calling them later asking them for this information. I have had to train information officers over a period of time. So you have to get to know the people, and you'll also know certain science writers are interested in certain kinds of stories. Maybe you'll pitch a story to them first before you go to someone else.

Question: I've heard two kinds of things in these different sessions. One of them is that newspapers tend to copy each other. Then I've heard you say you want only original material, or that you want something sent to you before it's sent to anybody else. There is a dichotomy here that does not match up. Am I missing something here?

Leary: There is pack journalism to this, but it's still very competitive. I am good friends with a lot of science writers in this town. We go to a meeting and a controversial story will come up and someone says, "Gee, I wonder how we are going to handle this." Someone will say, "Well, this guy lied to me in the past about his research and I frankly question his data." And someone will say, "Yes, I had a similar experience with

him." So we talk about that kind of thing. And we share certain professional knowledge about these topics, about whether something is news. If we're at a meeting, we may suddenly disappear to our hotel rooms and our typewriters are going like crazy. We may be writing the same story, or we're doing a very different story. One thing didn't come out of an earlier discussion about the AAAS survey on the type of stories that come out after a meeting. It appears the stories were all from the news conferences. If that survey had gone on six to eight months longer, perhaps you would have seen other residuals of that meeting. I'll talk to a scientist in the hall and say, "This is interesting; I'm not going to write about it now, but I'll call you back later." Six months later I'll talk to this scientist and say, "I heard you at the AAAS meeting; let's talk about it." In the story I don't mention AAAS, so there's no way anyone can know I got it from that meeting. Therefore, you miss seeing this individual effort on my part. You see the pack journalism, as it were, if you go to the news conferences, but you don't see what comes afterward. We compete very strongly with each other, but we are still colleagues and friends, and we share certain information.

Young: It's true that a lot of stuff comes out of the press conferences at the AAAS meeting. One of the reasons is that it gives you more time to grab those other papers, to find people to talk to in the hall for later use. If there were only some way to identify how many stories over the course of a year come out of that meeting. The American Psychological Association meeting is another great one to attend to get papers, meet people, and just follow up throughout the year on topics. Meetings are not being covered as much as they used to be. There is more of a trend to attend specialized seminars. Another technique is to go out on reporting trips--we go for three or four days into an area and hit one city, maybe an institution or two, move on to another city, and pick up a variety of stories. Usually we've got something in mind when we go out on these things. Sometimes we call somebody up and say, "Hey, I'm going to be in town. I've got a story over at this university. What have you got in your shop that might be interesting?" We tend to do that with people we know whose judgment we trust. A lot of this business is based on trust. It's the trust of the scientist in the writer and the trust of the writer in the scientist. There are scientists who exchange notes among themselves on science writers.

Question: In your view, is there justification for the use of an exclusive? If so, when do you think that justification exists?

Young: When I get it. If I do not have that exclusive, there's absolutely no reason for anybody else to have it. We are sort of a different breed in science writing. We still work for newspaper editors, and we are still under the constraints of their thinking. And they decide what gets published, not us.

Question: On the subject of trust, scientists don't trust us, and editors don't trust us because they think we're after free advertising for our institutions. So we have special problems. We're almost better off if we don't have friends anyplace. Your friends on newspapers stop being

your friends the minute you try to sell them a story. Scientists may go to parties with us and have a good time. But the minute we try to do something on their research, we get a closed door. How can we deal with this total lack of trust?

Leary: There are some public information officers whom I trust. They will call and say, "I just put this release in the mail; ignore it." And we realize what constraints they are working under. We talk to them about it. This is not uncommon. A public information officer will have to put something out and doesn't want me to think it was his or her judgment that the story was worth publicizing. I think more highly of that person for that. I also can short circuit some of my editors who might also get the release and want to know if it's a story; I can tell them it isn't. We do develop these relationships with public information officers. Some become friends and we have them over to our homes for dinner when we're not working, and no one is trying to get an exclusive. But we can call up someone and say, "Look, I have this. What do you know about this person?" And the information officer can say, "Wow, he's kind of flakey." There is trust, and I tell information officers initially: "We're going to get along very well if you never lie to me. If I ask you something that you can't comment on, just tell me you can't say anything about it. And I understand the constraints. But if you tell me one thing and I find out later that you've lied, that's a very different kind of thing." Then that person loses my trust. We level with information officers and try to understand what their jobs are and the constraints they are working under. And once we understand that, we can have these kinds of conversations. We can call up and say, "I hear this is going to break." And rather than saying, "No, I don't know anything about it," the information officer will think of some other basic way to say, "I can't comment on it." At least they didn't say, "No, it's not going to happen." They didn't lie when they had certain information.

Young: Another thing involved is simply respect for talent--does the information officer know what's going on at the institution? Does he or she have good judgment about what is news, what is valuable, and what is important? And is the information officer willing to be cooperative and helpful? A lot of it is mutual respect, and, frankly, sometimes personality just comes into play.

West: Regarding trust from scientists, it would be a real service to us if you can cultivate those scientists, convince them that your job is not threatening them, and give them good examples of people who write well about science. Show them what other people in the media can do and cultivate their trust that way. A lot of scientists have been burned, and it's hard to get them to talk to reporters or public information officers because they have had bad experiences. But you just have to try to convince them. It's also helpful to explain how the media work. If scientists know what a story goes through while it's being written, if they can understand that news process, maybe it will be easier for them to see how those mistakes can occur or how to correct them. There are a lot of researchers who have been burned. The classic example is the scientist in California who came up with the theory that an asteroid hit the earth and

killed the dinosaurs. The first time that came out it was reported as being a super nova. He did not say it was a super nova, but one of the papers picked it up that way. He didn't know whom to go to; he had no idea what steps he could take because that's not his world. And if somebody at his university had said, "Call the city editor and get the paper to run a correction," he could have handled it. But scientists are unfamiliar with the way the media work.

Leary: Few scientists have gotten burned as such; they think they have. With a lot of them, it's word of mouth--their friends tell them that they've gotten burned.

Young: They may well perceive that they've been burned because any degree of simplification is considered an inaccuracy; therefore, the reporter is inaccurate. I once addressed a meeting of neural scientists, and they wanted to know how we did our jobs. I told them to expect some distortion because the work they do is so complex. With the limited space I have, I'm going to have to simplify, and any simplification is going to be a degree of distortion. And that's true. It's very helpful when scientists can give you a good analogy. They're usually much better at it than we are. This is still an adversary business in some ways. There is more and more this question of who's gaining what out of what. You can manipulate the media; it's not that hard. But you don't manipulate me more than once.

Question: When you get a release on a science story, do you prefer it to be short and concise or longer and more detailed?

Leary: I personally want it longer, but we all have our different preferences. What some people are doing now is using a short version on the front and then attaching a copy of the paper or speech. I'd rather have more information than not enough, particularly when I have to sit down and write on a deadline, or if I won't know where the scientist is. A paper will come out and Dr. So and So is down in Bolivia. It's kind of a good story, but we can't get to the scientist. So we ask information officers to try to find out where he or she is, or if there are any coworkers around. I'm on a tight deadline. I can't wait two weeks for the scientist to get back. So I'd rather have more good quality information than not enough.

SERVING TWO MASTERS: JOURNALISTIC CREDIBILITY AND INSTITUTIONAL INTERESTS

Dr. Allen L. Hammond
Editor
Science 81

Paul Lowenberg
National News Coordinator
University of California, San Diego

Robert Bazell
Science Reporter
NBC News

PAUL LOWENBERG

One of the dilemmas that all of us face is credibility as public information people. How do we establish our credibility? Why should a reporter believe what we have to say? Why should faculty members believe us when we tell them about the media? We have to establish our own presence on the campus.

We also face a conflict of science writing versus public relations. What are we? As information people on campuses, we want to be accepted as writers; we want to be accepted as authoritative, knowledgeable people. But we also wear that public relations hat, and therefore we're subject to a number of different pressures from deans, department chairmen, chancellors, and presidents who face problems other than communicating science research. They're worried about student enrollments, about making the campus look attractive, and about alumni. These are all competing pressures. Scientists, themselves, have pressures. They're pressured for tenure and to get grant money. It's up to us as information people to sort through this morass and find out what we should be communicating about the scientific enterprise to science writers.

This poses a real conflict. When is news news? What makes science news? Often we're the ones who have to determine that. We're called upon to judge when to publicize a story. What goes into that decision-making process? How do we decide when to report a story? When it's published? When we just happen to interview somebody and it sounds interesting to us? How do we publish that story? When do we publish it? Where do we market it? Our problem is that we walk in both worlds. We are the university when we're dealing with the media, and we are the media when we're dealing with the university. In that sense, we are outside the mainstream of everything.. When I interview scientists, often they're concerned because they think I'm the media and they think that if they're telling me, they're telling The Los Angeles Times or the San Diego Union. They may well be doing that in some ultimate sense of the word, but there's a suspicion on campus that we're the media and we're not to be trusted. There's also the suspicion off-campus that we're the university, and we're trying to market a story. I'm curious about the role of the

information person. How do the media view the viability and credibility of the public information function? What's the sorting procedure of information officers to determine what role they really do serve?

ROBERT BAZELL

I deal with public relations people at universities a lot. There are good ones and there are bad ones. And it might be wise to talk a little bit about what the difference is. A bad public relations person thinks that everything going on is important, or that nothing going on is important. Both are equal sins. I maintain that the latter is more of a common problem. There are people who don't even know what's going on in their own backyard. More often than not I don't come up with stories through a university public relations office. This isn't because I've conducted an incredible investigation where I've gone through somebody's garbage in the lab, have come up with a missing test tube, and have discovered that this person has three-headed monsters in the back room. Often a research report has already been published. And often some other scientist will ask, "Did you hear that Joe Smith and Dorothy Jones at the university are working on that? That's really interesting stuff; I heard it at a meeting the other day." Then I'll call up the public relations person and he or she will say, "Oh! Really?" So that's a real problem. I can empathize with you because I know what it is like to go around and be treated like a leper when you're trying to find out what's important.

I also want to emphasize that public relations people should know what a good story is. Your job requires to a large extent the ability to be a reporter, even if that wasn't your background, even if you came into your job through some other route. You should face the fact that this is partly what you're doing, and you shouldn't grind out news releases to use up paper and ink. Maybe you should be sending them only to areas where you think they are going to be used. You watch local television; you read the local newspapers. You should ask: Is this a story that would fit with them? If it isn't, don't bother. The same goes for dealing with the national media. On the other hand, there are many stories in almost every institution that you can make interesting for newspapers or magazines.

There are other situations. The scientist down the hall published something yesterday that got picked up by The New York Times or The Los Angeles Times this morning and I'm one of a horde of reporters calling you up and wanting to come into the lab to take pictures. The scientist thinks this is the most obscene thing that's ever happened to him or her and doesn't feel any responsibility to do this. Obnoxious managing editors are screaming at you: "Why can't we have this? You gave it to the other ones in there!" You have to be ready for that moment. It's like being a pilot of a 747. The automatic pilot is on most of the time, and it's a really boring job. But when that tiny airplane starts coming at you, you have to know what to do. It's the same in your case. And that really is the second crucial test of a good PR person or a bad one. There are

ways of handling that, of dealing with the pressure, of orchestrating the situation so most of the media get what they want and so the National Enquirer doesn't get in ahead of Associated Press.

ALLEN L. HAMMOND

The most important part of serving as a useful conduit between scientists and the media--implicitly, between institutions and the media--is to be aware of the needs of the media you are serving. Not everything is interesting to everybody. We get lots of news releases, but probably a tenth of those are worth reading. The rest are simply not the kinds of stories we run. Public information officers should reflect on that and tailor their messages accordingly. Even so, a news release has about a one-thousandth chance of getting into the magazine. It's probably also true for getting a story on the air. So for those few stories that are really worth something, that really have a good chance of being picked up, you ought to calibrate a little higher. And maybe a letter is better than a news release. If you're trying for national media, a letter gets read more often than a news release does.

You need to use some selectivity and have an understanding of what's likely to be used by the person you're trying to get to use it. That means you have to know the medium. In trying to get on the "Today" show, you had better watch the "Today" show. If you want to get in Science 81, you should know what we do and then have the judgment to select those things that are of interest. It may not hurt to try to place lots of material that isn't very interesting, but it doesn't enhance your reputation as a source. The better you become at functioning as a reporter and covering your own institution, the better you will be as a public information officer.

The number of times I have called a university press office for help on a story is fairly small. I normally find out about things through the scientific community, and I normally go directly to the source. If I call the university press office, it has more to do with control of access for one thing or another. For example, I know about a story; the press office isn't going to make it public until a certain time; the office controls photo opportunities or access to that kind of thing. Those negotiations are important. Handling that part of the job well is important. Everybody wants to be first and to have an exclusive. How well you handle that is important. How you want to handle it, in fact, depends on what your motives are, on who you think your best play is. There are a lot of good stories out there that never go anywhere because they're not visible. And we have our own channels. Any good news operation has its own channels. For everything we pick up, however, there are 10 equally interesting stories that aren't done. The more you know the people in your own institution, the better you'll be. If it's a major university, you've got your hands full. My instinct is that a lot of the things pushed on you by your institution to keep you busy are relatively ineffective. You can spend your time better by knowing what's going on, knowing the people, getting their confidence, and therefore being able to

be an effective alerter. You'll be better able to recognize when you've got a story that really could get some play if you get it to the right person. Secondly, when a news event occurs and you're trying to track it, you'll have a much better chance of success if you already know the scientist involved, have some working relationship with him or her, and can, in effect, advise the scientist on how to handle the traffic. My own perception is that the quality of people in the university news offices has gone up very sharply in the last five years. I don't sense that the potential is being well used in terms of direct contact with established media.

There may be another channel. We're a free-lance magazine; we're always interested in people who can write well and do good stories. We're obviously not going to buy a story by a university PR person about his or her own university. But science rarely happens in one place. Professor X may have done something interesting in immunology, but immunology is a big subject and there's a lot more going on in that area. If you're sharp enough, you're in a wonderful position to pick up on those kinds of things early, to see trends, to put together stories that you can sell to people like us. You have the license to do that kind of thing, and you have to take a broad view of your job to do that. You can't think that the only thing that counts is a story about your institution or your professor. In some cases, better visibility may entail a story that is quite broad, one in which a principal investigator happens to be at your university. That kind of visibility in a major national magazine or on a major television program is worth as much, maybe more, than local stories about the wonderful Professor X. If there is a way to improve what you do, both in terms of the normal PR function and in terms of this larger role, it is to be better writers and journalists. Cover your backyards better. Look outside your own backyards and cover what's going on across all of science. Use that as an information base from which to generate things that, in fact, get published and influence the flow of information and discussion on the national level. We're very open to things like that. And so are other magazines that buy free-lance copy. I think that if you look at it correctly and can escape the immediate pressures to bring out X, you have a wonderful base to offer. And my suggestion is, use it.

Question: If a group of information people at several universities were to manage to break down the institutional barriers and pool their resources to produce a joint story on a national scope in some field of science, would that be acceptable to the national publications?

Hammond: I'm leery of jointly authored stories; committees don't write well. I would rather deal with a writer in most cases. Doing it that way begins to arouse my suspicions. It's a concerted PR thing, and I don't have the same confidence I do if I'm dealing with a writer and know where he or she is coming from. But why not pool resources, talk with your colleagues, and know what's going on? Then individually you can write your stories. There are lots of magazines and newspapers out there. You escape the sense of "flackery" when you broaden both your sources and your scope beyond the immediate university. I suggest that's a concept worth promoting to your internal structure. Indeed, your institution's

scientists would like to get mentioned. But isn't it equally important that the work itself is discussed in context, which invariably is multi-institutional? Let me ask you people a question: What do you want from us? What's wrong with the way we operate? I'm sure there are about 10,000 things. You must talk about them when we are not in the room.

Question: Frequently scientists are asked to explain very complex stories in 15 seconds. In the news industry, is there any movement toward doing fewer stories on the evening news programs?

Bazell: No. The evening news programs are a headline service that gives the day's news. However, there is a movement toward doing longer pieces. NBC does something called "special segments" as part of the nightly news. These are much longer than normal, although they're still not long. The other two networks are doing the same thing. Also, I do a regular thing on the "Today" show every week that is just about science, and it's more relaxed. It's still not as long as I'd like it to be, but the time is very valuable. And five minutes on science is a lot for "Today." I don't maintain that if something is important it can't be condensed. If it's so complicated that it can't be explained in a few sentences, then it's not important and it's not news.

Question: I think that's the media reaction but I don't think many people believe that.

Hammond: An editor of mine once said that any story can be written any length. It's true that you lose something in the shorter length, but it's also true that most important ideas in science are relatively simple ideas. And most important impacts on society are also relatively simple, at least in an overt sense. Either people died or they didn't, or rats died or they didn't. We always have the problem of oversimplification, even in a magazine like Science 81 where we have what we might call the luxury of 3,000 words to deal with a topic. We get complaints from the scientific community that the magazine is too superficial and that we don't put enough science in it. But to complain about that is to be unrealistic. You're dealing with the way the world is. The essense of the problem is that, in fact, being articulate and direct is a skill that's useful to have when you're trying to deal with the constraints of national media.

Question: Do you at NBC raid Hammond's material in Science 81?

Bazell: I could raid it only after it had been published in Science 81 and then it wouldn't matter anymore. But I haven't yet. A lot of material on TV has already been in a newspaper or in a magazine. Exclusivity is a very clumsy thing. Unless it's some investigation of wrongdoing or something that is really going to focus national attention on the medium, it doesn't matter to me if a story has been run somewhere else. Particularly when it's a feature article, if it's interesting, I can do it again on TV. And television is so different from a magazine in terms of how it affects people and how it's perceived that it really is no big deal to do a story that has been in a magazine.

Question: What do you do to determine your stories? Can you give us a little idea of how much material you get?

Bazell: I have a full-time researcher who reads all the press releases sent to me. I ought to put in a plug to get more. Despite what I've said about the usefulness of most press releases, only about 4 percent of the universities send me material, and I would really like to hear from everybody. I think this is true for most science writers. But, again, I want to hear only about the work that is really good. My address is NBC News, 30 Rockefeller Plaza, New York, NY 10020. I go through journals; I go through press releases; and I talk to people. There's no other way. And I read the newspapers.

Question: Mr. Bazell, how big is your travel budget? Do I have to wait for my colleagues on the West Coast to produce worthwhile stories before NBC would come to see us?

Bazell: My travel budget is unfortunately very large. I spend all my time on the road. For example, I went to Seattle recently for one day and for one story. That happens all the time.

Question: Do you like freelancers to come to you with ideas or do you want to hear from the university PR office?

Hammond: Both. We work on a written query system because otherwise the phones get too busy. We are open to queries from anybody, anywhere, at any time, either for feature articles or for the shorter articles in the back. In effect, we commission nearly everything. About 40 percent arises from ideas that come in on queries and then we go back to those people. On the other hand, any time an event happens, we immediately get 20 queries on that subject. And if we ever do anything on it, then we get charges that we are stealing ideas from them and not going back to them to write the stories. You have to be a little realistic about the process. But about half of the time we come up with our own ideas and find a writer to execute them. The other half of the time we get ideas in, accept them or modify them, and go back to the writers to have the stories done. The "Crosscurrent" section in the back of the magazine is explicitly designed for getting acquainted with new writers. It's a looser format both in style and subject matter, and it's a good place to experiment. That's the basic process. Try an idea on us, send us a couple of paragraphs that tell us what the idea is, and we'll get back to you.

Question: If you get the idea from a PR person and like it, would you assign it to a writer?

Hammond: Yes. Write me a letter. Let me know about it. Or write someone in my senior group. Tell us what's important and why, some of the antecedents, and who the people are. You can do that in a paragraph. And we'll be glad to have a flow of that kind of material. It's informative; it's actually better than a press release, from my point of view, because it shows that somebody thought about this magazine and decided

this story would be right for us. We would love to be alerted to things. As I said, there's no way, even with all our channels and AAAS access routes, that we can know a fraction of what's going on out there. Let us know about it. We'd be delighted to have those kinds of tips in that particular form. A tip in a letter leaves us completely free to do what we want with it. We may even come back to you and ask if you know any good writers who may want to do it.

Question: But you prefer going to a free-lance writer first?

Hammond: We probably would go to a free-lance writer.

Question: What if we went to the free-lance writer first with the idea?

Hammond: You could also feed it to a freelancer and get him or her to query us, if you want. But we have lots of writers. It's easy to find writers to do stories. The key thing is knowing there is something there that fits our needs, particularly stories that are coming up. We'd like to know if you see a lot of interesting things developing in a field on lots of campuses, one of them is yours, and you've got key people who are excited. They may have some publications coming up in six months and some other key experiments underway. Let us know about it. That is something we can monitor for a few months and jump in at the right time. That kind of material is invaluable, particularly in a magazine with that kind of lead time. We don't wait for events; we're not, in fact, very responsive to events, in contrast to television and newspapers, except when they do features. We are a feature magazine, and when you're doing color printing, you don't do it overnight. So alert us if you see activity building. That's the key thing. If you do that, you've done your job because if we want help in getting the material written or photographed, we'll come back to you.

Lowenberg: I'm curious about how various people on the campus go about determining what's important enough to send to Al Hammond or Bob Bazell. Does anybody have any formula for that? How do you decide what to write about?

Answer from the audience: You should ask three questions: Who wants to know? Why do they want to know? And why do they want to know now? If I can get good answers to those three questions, I'll pursue the story. I have a couple of times pulled my name off of a press release. I'm ashamed to send the press release out by the time the administrator is finished putting in the quotes or making other changes. Administrators want to make it more sophisticated, meaning a little less understandable. I find that a great problem. I think people in media ought to be aware that very often you may get a press release from a news person at a university and think that person doesn't know how to write. It may not be an accurate judgment. It may simply be that it was rewritten by an administrator.

Comment from another member of the audience: If I feel a need to do so, I show stories and releases to the investigators involved. They don't go

through the administration. If an investigator says he or she wants the release to be more precise, I negotiate on the wording so that the explanation is still in lay language but satisfies the investigator. It has to go back and forth until you're both satisfied. That seems to work in my experience.

Another comment from the audience: You ask what you as science writers could do to help us. When you visit campuses, I know you don't have any more time than we do, but it would really help if you could take some time and talk to a handful of hastily gathered faculty members and tell them the facts of your life--how you do business, what your constraints are, what you expect of them. I've spent the days at this conference wishing about 250 people I know were here. That's one thing. I try to get media people to come to our place, but they don't have the time or the interest. The problem I face is naivete on the part of the faculty regarding the real world of news gathering and dissemination. And I try to get news people to come in and meet with a few faculty, or at least my boss, to explain how they do their work.

Bazell: It's something I would be willing to do if I had time, which is sometimes. It is generally better than being taken on a tour of yet another lab. That's a good idea, and I would be open to that. But it's never been suggested to me.

Hammond: Have you thought of actually putting together a symposium on how to deal with the media and inviting precisely those people who complain all the time? In my experience a lot of the people in the science journalism business see as a serious national problem the arrogance or unwillingness to communicate on this side of the community. It is serious in the sense that it wounds the scientific community as much as it does the general public. So most of us feel that if you give us a podium we'll wait for people to show up and we'll be more open. We're interested in that professionally. So I think if you hire a hall and get an audience, it's not too hard to attract the speakers, and maybe that's the way to do it.

Lowenberg: I think the real heart of the problem is this: Why isn't the faculty listening to the public information officer? Why isn't he or she the one that can explain to them what the problems in the media are? I think we all suffer from this. I'm referring to the credibility of the information person as the media representative on campus as well as the campus representative to the media. As I see it, the function of the information person is the go-between kind of function. We shouldn't have to bring a media person on campus to explain the problems. We should have the credibility on campus to be able to explain those problems.

Comment from the audience: I'd just like to mention that last year at the University of Toronto I set up some workshops on how to deal with the media and how to be your own reporter. I got a television reporter to come in and tell what his day was like, explain the steps of doing a news show, and do some test interviews with some of the people there. It was very good. But I got the middle management people there. I did not get any of our top administrators.

Question: Are you interested in talking with administrators?

Bazell: Administrators don't have news stories; they can have a negative effect in that they can stand in the way. We in media can really be obnoxious and often are. And a lot of times when scientists say they don't want to talk to us, they really have a good reason, based on what's happened to their friends or to them. It's not just that these uptight scientists are concerned with keeping their secrets and their specific details intact. They have good reason to be afraid of the media. One of the things I ask public information officers is to be selective, because some scientists are not as good as others in dealing with the media.

Comment from the audience: I've found from my own experience that at the end of an interview the scientist is most likely to give me suggestions about other people to talk to. If I see the scientist in the hall or at a party, I often get a blank response to questions of what's going on. And at the end of an interview, it's different. It may be that the scientist is then in a frame of mind to think about things from that point of view--from the standpoint of a news story--and it makes him or her better able to think of what else is going on in the department. And I just go from one story to another like that. Many of the things that I'm referred to are things I would have found out in other ways, for example, from the name of the grant. But occasionally I run across something that I would not have recognized as a possible story from the names of the grants, if the names are very technical. And yet these are things that I don't learn about in more social situations.

Hammond: One of the reasons I thought it appropriate for the AAAS to start a popular science magazine was that I hoped it would legitimize to the academic community a bit more the idea of popular science. And in fact, I think we operate like any other magazine or any other news organization. But nonetheless, the academic community may view us as different, since the magazine is published by the AAAS. The scientists may feel we have to respect scientists and deal properly with them. And we try to do that. The experiences are sometimes negative. We just had a story that we held for three or four months at the plea of the investigator. Even though we obtained the story independently, he wanted us to wait until his work was accepted by The New England Journal of Medicine. Then he promised that we would have prior access. When it came down to it, he couldn't deliver the prior access, so the story ran after it had run other places. Basically, we felt burned. But we are in principle willing to be cooperative. And because we are published in effect by the scientific community, there are no formal constraints except an implicit one to behave in a responsible manner. If that's a useful ploy to get people to open up or to cooperate, we're delighted.

Question: Getting back to the credibility, I don't know if I'm extremely lucky in having a wonderful university to work for, but I don't have any problems. I suspect it's because I was the science writer for the local newspaper for nine years and people know me and, I hope, respect me. I

wonder if public information officers who were in the news media find their jobs easier because of that?

Comment from the audience: I find the opposite. My background is in biology and that gives me credibility with the scientists. If I had a media background they would treat me just the same as everybody else.

Comment from the audience: One of the things we've done at the University of Massachusetts to establish some credibility is to publish our own magazine, Reports on Research. Over a period of five years essentially one of the steps we've taken to gain credibility with the faculty is to see not only that scientific material is reported, but that it's reported with a certain amount of depth and sophistication. And as a result, if we could only sit in the office, the scientists would come to us.

Hammond: I'd like to put in a plug for these university magazines and the national lab magazines, which I think are a very sophisticated form of PR. I think they're also valuable because they do train writers. It's very hard to break in as a beginning writer, and that's a very nice place to show that you can write. We like to see those magazines; we look at them very carefully, not only because there are some good stories there that we can jump on or do versions of, but because we're also looking for writers. We are always looking for writers. I think those kinds of publications tend to serve their institutions well. But they also serve other publics, and I'm one of them.

Communicating University Research: Mediating The Message

UNIVERSITIES AND INFORMATION ABOUT RESEARCH: THE NEW AGENDA

George Keller
Assistant to the President
University of Maryland

When you think about it, the situation is peculiar.

Excluding military and applied industrial research, the overwhelming portion of America's research is being done at our major universities and best colleges. To put it another way, in the three decades since the end of World War II, America's universities have dramatically increased their emphasis on generating new knowledge and information and now constitute a network of research institutes that are indispensable to this nation's leading position in medicine, science, technology, agriculture, computer science, and social studies. Indeed, this network is now the critical factor in the country's progress. As Peter Drucker wrote in his Age of Discontinuity, "Knowledge, during the last few decades, has become the central capital, the cost center, the crucial resource of the economy."

But these same colleges and universities, with only a few exceptions, still use a strategy of communicating with the public and communications vehicles that derive from the 1950s, or even the 1930s. That is, the role of research universities in our society has changed radically, but university methods of public communication have changed very little.

* * *

The structure of communicating research from our campuses is fairly well known. By tradition, it has three prongs.

For reaching other scholars, the professors write in their discipline's learned and semi-scholarly journals. For alumni, friends, and opinion makers, the campus publishes an alumni or college magazine, newsletter, or newspaper. And for the general public, campus public relations officers turn out news releases and features for the papers and newsmagazines, and they try to influence reporters and editors of The Los Angeles Times, The Houston Chronicle, or The Toledo Blade, and Fortune, Newsweek, or Science 81 to do a story about the best work at their institutions.

This three-pronged structure is obviously a bit simple. The more enterprising campuses also send out radio spots and try to entice television news people to the university. Several universities, such as Berkeley, Brown, Johns Hopkins, Harvard, and Princeton, have splendid university magazines that report on research as well as new deans and programs, sports, and successful graduates.

Several other universities, such as Georgia, Indiana, Michigan, Ohio State, Rutgers, and the University of California at San Francisco, have recently begun magazines devoted largely to reporting research, and

most are well-written despite their often heavy public relations tone. There is editor John Mattill's excellent Technology Review, a semi-popular magazine that MIT sells on newsstands, Dr. Timothy Johnson's informative Harvard Medical School Health Letter, and editor William Kell's new magazine, Research, for the University of Minnesota. For three years I edited a research quarterly for the State University of New York called Search, which tried to break new ground by relating in-house research in many academic fields with the state of knowledge nationally.

In the past five years or so, there has been an extraordinary takeoff at some of our best universities in trying to reach out to the public, a trend that has paralleled the outburst of new commercial magazines covering science, technology, and social science.

But on the whole, universities have not yet developed their own communications vehicles for the public, like Scientific American, The Public Interest, the Wilson Quarterly, and Great Britain's The New Scientist. A few campuses have their Kenyon Review or Virginia Quarterly for literature and opinion, and there is the famous Harvard Business Review. But few have similar publications for science, technology, medicine, or social science research as yet. We make almost no films for the schools, other colleges, television, or the commercial market. There are few records or tapes that we issue like books from our university presses or elsewhere on our campuses.

For the most part, higher education has tended to stick with our sacred trinity: the learned journals, the magazines or newsletters, and the public relations entrepreneurs pleading with and pushing among the commercial mass media for space and attention. This is despite the enormous growth, quantity, quality, and importance of university research since the late 1950s.

So we have this situation. Universities have changed. The pace of research has changed. The educational level of the public has changed. The place of science, technology, and social science in our lives has changed. The interplay between campus research and business has changed. (Think of the recent interferon phenomenon.) And the technology of communication has exploded. But the structure of communicating university research remains pretty much what it was in the late 1950s.

There are many reasons for this. You could probably name a half-dozen--from most universities' astonishing neglect of the public that supports them and the difficulty of the language of research, to the fact that good science writers and editors are as tragically scarce as black mathematicians, and our inability to get out of the creativity box.

You all know the standard little test on creativity quizzes, where the problem can be solved only by going outside the self-imposed limits of looking at the problem. Well, most of us tend to continue blaming the media for not covering science, research, and hard education news adequately, which they don't; or we struggle to do a few more news releases or devote a few more pages in the alumni magazine each year to

research. But we seldom, if ever, sit down to design a fresh strategy for communicating research to our new publics, using the amazing new technology available.

* * *

I think the time is at hand for a leap out of the traditional box. I suspect the need for better communications is approaching crisis intensity. And as a writer-scholar, I am fully aware that "crisis" is a word that should be used sparingly.

I believe this is so for a number of reasons. I'd like to describe just three of them briefly. I have chosen these three partly because they may not be among the usual ones people think of.

The first reason is that Americans now have a deep ambivalence toward science and technology and indeed all research. And this ambivalence is potentially disruptive to universities.

We are both fascinated by and fearful of scientific research. Once we were convinced that science, discovery, and technology held a marvelous future for us. The 1939 World Fair in New York nicely revealed that confidence. In the 1960s we were persuaded instead that science and technology were life-destroying rather than life-enhancing. Now we are profoundly ambivalent.

We are comforted, say, by pharmacology's ability to relieve the nightmares of mental illness by various drugs that manipulate the brain and nervous system; but we are almost equally afraid of that kind of neurobiological research, even though it is one of the most exciting new fields in science. We are aghast when scholars like Arthur Jensen and Edwin O. Wilson begin poking around in human genetics; yet in the core of our brains we know that genes make a difference in breeding our dogs and horses and that human beings are a product of Darwinian evolution like all other forms of life on earth.

I believe this mood, this deep ambivalence and uneasiness, affects our universities and their support, especially the funding for research. The U.S. Congress especially is full of wavering and equivocation. The ambivalence certainly affects academic freedom, as Harvard and others discovered in the recombinant DNA controversy a few years ago.

Perhaps ambivalence is proper and inevitable here. But surely some alleviation of the growing emotionalism surrounding science, technology, medicine, and social science can be gained by helping people have a better, clearer understanding of who scientists really are, why some professors delve so fiercely, how researchers work, what place a piece of research occupies in our knowledge of certain areas, and what it could mean for us both positively and negatively.

Unless we communicate better, the continuity of support, which is so important for research results, could be disrupted by the widening oscillations of the public and its nervous legislators.

Second, there is the disjunction between the needs of our society and what is happening in American education.

On the one hand, we can document the growing importance of basic research, applied research, and social research. Whether you examine how we travel, what we eat, how manufacturing is done, the ways we communicate or process words and images, the methods of treating cancer, or how a company tests a product and advertises it, you will find a growing use of electronics, biochemical science, astrophysical research, and the latest findings of sociology, economics, and psychology.

There is growing talk of "reindustrialization," the need to retool our research and development capabilities and our industrial economy to meet the strong economic challenges of the Japanese, Germans, and other nations--in everything from automotive engineering to semiconductors. We look to research to help us out of the very serious problems of our rapidly dwindling supplies of petroleum and natural gas, which currently supply 75 percent of our energy, through such miracles as solar energy, nuclear fusion, or hydrogen energy.

Yet on the other hand, the nation borders on scientific and technological illiteracy. How many people know how electricity is made or can explain how their automobile engines work? The SAT scores in mathematics and science keep dropping slightly every year. According to the 1978 National Assessment of Educational Progress study, the 1979 National Research Council study, and President Carter's study, "Science and Engineering Education for the 1980s," there has been an alarming drop in high school instruction and learning in science and mathematics in the past decade. The number of students taking science courses has decreased from 18 percent in 1968 to a mere 10 percent in 1978. Two-thirds of the school districts require only one year of science for high school graduation; and there is pitifully little science taught in most elementary schools. Nearly 55 percent of all high school graduates never go beyond 10th grade biology. Half the high schools in America no longer even teach physics. Only 7 percent of all college-bound students take advanced math or calculus. In 1979 alone the National Science Teachers Association lost nearly 1,000 of its 10,000 members.

At the college level, enrollments in science courses are decreasing, and until last year the number of engineering students was declining. In 1977, 43 percent of all Ph.D.'s in engineering went to foreign students. There is an acute shortage of computer scientists, especially in software engineering. Federal support for graduate study in science and technology has declined to one-fourth of what it was 15 years ago. Saddest of all, black students are extremely rare in the physical and life sciences, engineering, agriculture, computer sciences, mathematics, and increasingly scarce in the professions of medicine, dentistry, and architecture, and in advanced research, except for a few fields like history, sociology, or education.

I think it is evident that our complex, scientific society and our educational system are out of harmony. While our culture depends more and more

upon research and advanced technology, growing numbers of our young people, beneath the top 3 or 4 percent, are remaining dangerously ignorant of science, mathematics, and technology. And science is the most exciting intellectual adventure of the 20th century.

While the Germans, Japanese, and Soviets are increasing the depth and rigor of their schooling in science, mathematics, engineering, economics, and foreign languages, our newspapers currently devote more space to astrology, according to one study, than to all their science and medical news combined. We are experiencing a huge revival of mysticism and cults and witnessing the spectacle of a new wave of nuclear protestors, many of whom could not tell you what radiation is, what levels are dangerous, or exactly what would be radiated across the land if there were a nuclear power plant leak.

Surely the best colleges and universities, which are at the center of this country's research, have some responsibility to expand their communications about research and scholarship, to counter the growing trend to pseudo-science and superstition, from biorhythms to the Bermuda Triangle, and to help bring education more in line with the basic information needs of our advanced society.

There is a third and more insidious reason that universities should invent new strategies and vehicles for communicating their research. We have growing evidence that research and scholarship itself are being retarded by the lack of adequate exchanges of research news. That is, the productivity and creativity of our research faculty is being hurt by the present pattern of communications. Let me explain what I mean.

Much of the success of American medicine, science, and research has derived from increased specialization and competition. We have gone deeper and deeper into smaller and smaller areas. That success has been enormous, as the latest batch of Nobel Prizes testifies. But the consequence of this still intensifying specialization has been that the disciplines have moved farther apart from one another.

It is rare for a scholar today to read outside his or her own specialty. The American universities are becoming increasingly fragmented. While the accomplishments of research have become more impressive, the breakdown of communication between researchers, and between researchers and the public, has become more ominous.

Rogers Hollingsworth of the University of Wisconsin spelled out some of the results of increased specialization and the collapse of communications in a remarkable paper he delivered at the University of Maryland. Leaning on his paper, I'd like to point to five of these results.

One is that the integrating mechanism of theory is being strained to the breaking point. Knowledge grows, but fewer and fewer persons are able to, or encouraged to, put the pieces together. Theory, which is such a powerful tool for research and often drives experiments, is disintegrating.

Whole fields are in theoretical disarray. If you want a juicy sample of this, read the special 1980 issue of The Public Interest devoted to "The Crisis in Economic Theory." In medicine, doctors in one specialty are having increasing difficulty communicating with their colleagues at the same medical school.

Second, the consequences for teaching at the universities are serious. Curriculums today resemble patchwork quilts rather than well-conceived, student-oriented introductions to scholarship. Liberal education is falling apart, and students more and more search for meaning from itinerant maharishis, professional radicals, drugs, or exciting personal experiences.

Third, funding for research becomes more precarious because researchers write mostly for the other specialized researchers in their field and speak less and less to the public, the media, or government agencies and legislators. The relevance of some research becomes more and more remote, and the Senator Proxmires have a field day twitting the specialists. The financial support of research becomes more and more a matter, except to the small circle of peer reviewers, of blind faith rather than a reasoned selection of priorities.

Fourth, the social utility of research tends to diminish. Perhaps medicine is the chief example of a field where specialized expertise has reached extraordinary heights. But the attention to developing a health care delivery system appropriate for our times is minimal, despite the rocketing costs of modern medical and hospital care. Again, the integrative mechanisms are lacking, the theory underneath it all is threadbare, and the needs and problems of people seem overlooked.

Most of the ill health of our time, thanks to the extraordinary success of medical research, stems from such causes as smoking, obesity, drug consumption, crime, alcoholism, toxic chemicals, accidents, and mental health disorders. Yet curative medicine concentrates on cancer, cardiovascular, kidney, and pulmonary diseases of the elderly, which as Dr. Lewis Thomas and the late Dr. John Knowles have pointed out, may not be susceptible at all to cures and may represent a touching but unwise investment of scarce financial resources.

Fifth, and perhaps most ironically tragic, is that increasing specialization and the lack of communication across disciplines are gradually weakening the quality, power, and creativity of research. Several investigators like Donald Pelz have demonstrated that one of the best ways to enhance academic creativity and productivity is to bring people together from different fields. For example, the DNA discovery was facilitated because Jim Watson was a biologist and Francis Crick was a physicist, and they both met Rosiland Franklin, who had expertise in x-ray diffraction. Life's problems and nature's mysteries are not organized into departments that match our academic disciplines.

Neither specialization nor interdisciplinary work is inherently superior. It is the interplay between specialization and interdisciplinary work

that is most conducive to great research and indispensable for breakthroughs out of our current models of thought and behavior. Geniuses like Enrico Fermi, Albert Einstein, and Linus Pauling have frequently changed their fields of special inquiry and have constantly kept in touch with developments in other, allied fields. Ideas need to be jostled and seen from fresh perspectives to take a new turn. And experimental work to be most fruitful needs pollen from flowers elsewhere. Hybrid vigor applies not only to plants. Communication across the disciplines is vital.

* * *

I have talked a great deal about the urgent need for better communications about research, both among scholars and between researchers and the public. I have not offered any specific ideas about how to improve university communications, nor can I do so in the brief time we have today. I take some comfort, however, because others following me will address that subject and I am sure they will suggest some new directions.

The points I wish to submit are simply these.

Recent history and the rapid growth of science, technology, research, and social studies in the past few decades have raced beyond our present structure and trinity of communications--learned journals, university magazines, and public relations with the commercial media.

We need to change our attitudes about communicating with the public. We need to invent new strategies and vehicles for informing people about our scholarship and research. Just as the nation is trying to improve its "technology transfer," it should try to improve its "people transfer" or the exchange of science, technology, and social science research between the universities and the American people.

Criticisms and analyses of the functioning in our present, traditional scheme of communications are very useful. We need to do better what we are now doing. But we also should recognize that we must move beyond that onto new ground, developing fresh forms of delivery and harnessing the emerging electronic technology of communications. We in university life need to think more boldly and more innovatively, as our colleagues in the research laboratories are doing.

And we must remember that the consequences of not improving communications about research at our universities are quite damaging--for people, for progress, for America, for universities, for students, and for the researchers themselves. We simply cannot afford to go on doing what we have in the past.

In the October 1980 issue of The Atlantic, the novelist John Hersey has an article with a striking sentence. He says, "Numbers have become more powerful; words have grown weaker." It is a trenchant observation.

We need to restore the power and beauty of words, and add to them where appropriate the gift of pictures, if we are not to be drowned in

statistics, vast quantities of data, and sophisticated mathematics. We need to share more widely and describe more fully and frequently what we know and are attempting to know. We need to break out of our trinity and use the new technologies in creative ways.

Matthew Arnold put it nicely in an essay in 1867:

> "The great men of culture are those who have a passion for diffusing, for making prevail, for carrying from one end of society to the other, the best knowledge, the best ideas of their time; who labor to divest knowledge of all that is abstract, professional, exclusive; to humanize it, to make it efficient outside the clique of the cultivated and learned."

SECTION TWO:
SUPPLEMENTAL READINGS

READERSHIP AND COVERAGE OF SCIENCE AND TECHNOLOGY IN NEWSPAPERS AND MAGAZINES: REPORT TO THE COUNCIL FOR THE ADVANCEMENT OF SCIENCE WRITING*

Sana Siwolop
Graduate Student in Science Communication
Massachusetts Institute of Technology

SUMMARY

Is there a demand for science news within the American public? If so, is it being met by an adequate supply? According to research summarized in this report:

1. The American public enjoys the science news now available in newspapers and would like to see more of it. A 1977 Newspaper Advertising Bureau (NAB) survey, for example, shows that science articles are considered to be among the most interesting of all newspaper editorial items. In a 1975 Canadian government study, nearly half the respondents felt that the media were not providing enough science information.

2. A large segment of the population is now interested in science news. Reports from surveys and informal polls suggest that more young people, women, and college-educated readers are interested in science news today than in previous decades.

3. In fact, the public depends on the media for much of the science information it needs in daily life. A recent survey conducted by General Mills, Inc., found that American families rely on newspapers and magazines, second only to doctors and dentists, for much of their health information.

4. While the demand for science news appears to be increasing, the supply has stayed about the same since 1938. If anything, according to the NAB survey, the amount of science in newspapers decreased slightly during the 1970s.

Conclusions about current science readership and coverage must be regarded as tentative, however, because available data are limited in scope and/or out-of-date. New, comprehensive information is needed to assist science writers, editors, and policymakers in improving public understanding of science.

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WHAT IS THE DEMAND FOR SCIENCE NEWS?

> The public reads science news, wants more science news, and depends on getting its science information from the media.

Since the 1950s, surveys have consistently indicated that the public is interested in reading about science, and would like to read more. In a national survey conducted in 1957 and 1958 by the Survey Research Center (SRC) for the National Association of Science Writers, two-fifths of the 1,919 adult respondents wanted newspapers to print more medical news, and a quarter wanted more non-medical science news. Two-thirds were willing to have other news cut in order to provide more space for science and medical stories.[1,2]

A 1977 survey of 1,714 Americans by the Newspaper Advertising Bureau (NAB) suggests that reader interest in science news is still high. Science articles were considered to be among the most interesting of all newspaper editorial items. Survey respondents rated 24 percent of all editorial items and 32 percent of articles on science and technology as "very interesting." Science news had relatively strong appeal to infrequent readers, as well as to frequent readers.[3]

The NAB survey also showed a possible increase in sophistication among media consumers' news choices. Such items as advice columns and comics, which had been favored in a 1971 NAB survey, disappeared from the top of the list by 1977, while science-related articles on energy, public health, and the environment rose to occupy very high positions among the content categories most likely to be rated "very interesting." Furthermore, when survey representatives were asked to which subjects they would assign more space if they were newspaper editors, environment and health news items were among the most frequently mentioned. (The category of "science" was not among the choices offered.) Young adults under 30 ranked "consumer news" first, followed by "the environment" and "health/nutrition." The over-30 group placed "best food buys" first, "health/nutrition" second, and "the environment" sixth (behind human interest stories, editorials, and consumer news). Both groups allotted relatively little space to categories dealing with "mysterious/psychic predictions" and "astrology/horoscope."[4]

A survey conducted by the Gannett Company in 1979 also found high reader interest in science. Readers were asked to rank 37 categories of news on a scale of one to five, with five meaning "read all the time" and one meaning "read never." Two categories, "health and science" and "space exploration" both ranked very high in the readership category, with a ranking of 3.5 each. (Categories that ranked first, "world events" and "natural disasters/tragedies," had a score of 4.1 each.)[5]

Among magazines, a few publishers indicate that they have conducted extensive in-house marketing research, but the results are usually not available to the public. Whatever the evidence, it seems sufficient to have encouraged investment in a new array of popular magazines such as Science 80, Geo, and Omni.

According to a spokesman for the marketing division at Time, Inc., cover stories on science are usually among the year's five or 10 best-sellers. In 1979, a Time cover story on the evolution of early man was at the top of the list, while an Einstein cover was also an instant best-seller.[6] Time covers that have science-tagged feature flaps are also popular, especially in areas such as astronomy and medicine.[7] Time, Inc., is planning a new monthly magazine, Discover, based "largely on the evidences of success of the Time science section."[8]

When 2,000 Canadians were questioned in a 1975 survey sponsored by the Canadian Ministry of State, Science and Technology, four out of five of the most popular news topic preferences were science-related: education; medicine and health; pollution, ecology and the environment; and social issues such as overpopulation, urban planning, and child development. Only local news or local events outranked these four. Among magazine articles, close to four out of five readers found science topics both interesting and enjoyable to read.[9]

More than three-quarters of the Canadians surveyed wanted to keep abreast of science news. Yet 54 percent of these people felt that not enough science news was being made public, and 43 percent felt that the media were not providing sufficient science coverage. Half of those interested in science expected their science information to come from newspapers, while slightly more expected it from television and magazines. The authors of the report estimate that only one-quarter of the Canadian media audience feels it receives adequate science information.[10]

Major scientific events appear to increase the demand for science news. The second Survey Research Center (SRC) survey in 1958, a month after the launching of Sputnik, found that 9 percent more respondents read all or some science news than had seven months earlier. The greatest increases in exposure to science information occurred among women and the less educated--the groups least exposed to science information in the 1957 surveys.[11]

Evidence also suggests that the public depends on the media for the science information it needs in daily life. A recent study conducted by General Mills assessed common sources of health information among 1,254 American families. Doctors and dentists were found to be the most common source of health information, followed by television programs, news stories, health columns in popular magazines and newspapers, and health and physical fitness magazines.[12]

Americans may be more dependent on the media for their science information than they realize. In a 1957 survey conducted by Stanford University, people were asked where they would go, and where they did go, for information on cancer, child-rearing, and mental health. Nearly 90 percent claimed that they would consult a professional expert for information on these three topics, but only 10 percent had actually done so. Similarly, roughly one-third claimed that they would consult libraries for information, but fewer than 1 percent had actually done so. On the other hand, many more respondents had consulted both friends and the mass media for information than had anticipated doing so.[13]

WHO READS SCIENCE NEWS?

> The demand for science news varies according to the reader's level of education, income, lifestyles, sex, and region of the country. Generally, consumers of science information tend to have more education than average, higher incomes, and more positive attitudes toward science and technology.

At the time of the Survey Research Center surveys in the 1950s, the typical science news reader was likely to be male, young or middle-aged, well-educated, and in the higher income brackets. He also tended to live in West or Midwest metropolitan suburbs, and to have taken science courses in high school or college. Men in the surveys named the print media more often as a primary source of science information, while women named radio and television. Respondents within the 25-64 age group usually mentioned the print media as a primary source of science news, whereas the youngest and oldest respondents were more likely to name the broadcast media.[14]

No recent, comprehensive information about science news consumers is available, although the 1977 survey by the Newspaper Advertising Bureau shows a possible shift in science readership to a younger segment of the population. According to the survey, young adults (18-25 years) were more likely (37 percent) than older adults (45-plus years) to rate science articles in newspapers as "very interesting" (31 percent).[15] In informal telephone conversations, science magazine editors speculated that their audience included more young people, more women, and more college-educated readers than in previous decades. According to the executive editor of the new magazine, Science 80, published by the American Association for the Advancement of Science, the average reader of the magazine is about 35 years old, with an income between $26,000 and $28,000; 88 percent are college-educated, and 44 percent have some sort of post-college education.[16]

Readers of science news also tend to be people with relatively positive attitudes toward science. Among respondents in the 1957 SRC study, those who read the most science news also had the most favorable views of science. Nine out of 10 who read all the science items in their newspapers agreed that "all things considered," science had unquestionably made the world better. Among those who skipped science news items, only 73 percent thought that this was true, and of those who read no papers regularly, only 64 percent agreed.[17]

At the time of the SRC survey, the public in general had positive attitudes toward science. Subsequent surveys indicate only a moderate change. In polls taken for the Science Indicators reports published by the National Science Foundation, for example, scientists were described in favorable terms by 96 percent of survey respondents in 1972, 89 percent in 1974, and 81 percent in 1976.[18] Similarly, 80 percent of a California sample of people surveyed in 1972 believed that the net effect of technology was to make life better rather than worse.[19] Last year, a national poll taken for Union Carbide found that 60 percent of the 1,500

Americans surveyed believe that science and technology do more good than harm, 28 percent responded "about the same," and only 5 percent said they do more harm than good.[20] And among young people, the National Assessment of Educational Progress found in 1976-1977 that 58 percent of the 13-year-olds (compared to 65 percent of young adults) feel that science eventually will solve some of the nation's problems.[21]

There is, however, some ambivalence in public attitudes toward science. On questions of confidence in social institutions in a 1973 study, science and technology received the highest number of "don't knows." A substantial minority of respondents felt that "the degree of control which society has over technology should be increased."[22] Other research suggests that the public may be drawing a distinction between "science" and "technology" in which scientific research is seen for the most part as necessary and beneficial, but the possible hazardous uses of this research are seen as a problem.[23] Fluctuations in attitudes toward science, in response to social changes and events such as the accident at Three Mile Island, have not been studied.

To some extent, exposure to science news may lessen public hostility toward science. An intense media campaign on the subject of mental retardation in a small Wisconsin community in the 1960s led to large gains in information about mental retardation and fostered positive attitudes toward the subject among community residents.[24] In two sets of tests administered to students in 1970 and 1971, the reading of materials on varied scientific topics also resulted in more positive attitudes toward these areas of science.[25]

In 1979, a national survey of public attitudes toward science was conducted for the Science Indicators Unit of the National Science Foundation. The questionnaire was developed by the National Opinion Research Center, University of Chicago, and administered by the Institute for Survey Research, Temple University. Based on a national probability sample of 1,635 adult Americans, the survey measures patterns of media use as well as attitudes, and seeks to identify an "attentive public" for science. A report analyzing the main results will be available in late 1980, as will the data base for those who wish to conduct further analysis.[26]

WHO IS PUBLISHING SCIENCE NEWS?

> The demand for science news seems to be increasing, yet the supply of science news has stayed the same.

In studies of 29 newspapers in 1938, and 130 newspapers in the period from 1939 to 1950, only about 1 percent of the non-advertising space was devoted to science news.[27] If anything, the actual percentage of space given to science and invention news has declined; according to Newspaper Advertising Bureau results, space decreased from 1.0 percent in 1971 to 0.7 percent in 1977. Space devoted to environment and public health/welfare increased, but the articles did not generally have significant science content.[28]

It is not clear whether the number of newspaper writers assigned to science is increasing or decreasing. The 1977 NAB report indicated that 11 percent of daily newspapers had science editors,[29] and recommended that "science and its impact is a subject that deserves a greater share of newspaper resources and space."[30] Telephone calls to a few of the nation's largest newspapers suggest that, although newspapers are not necessarily increasing their number of science writers per se, some have increased the number of writers that specialize in a broad range of science-related topics. The Los Angeles Times, for example, increased its science writing staff between 1969 and 1980 from two writers (one medical writer and one science writer) to a present total of seven writers (two science writers, two medical writers, and writers specializing in energy, air and water pollution, the environment, and human behavior).[31]

In magazines, the most striking trend recently has been the introduction of new magazines that popularize science, such as Omni, Geo, Science 80, Next, a reformated Science Digest, and Discover.[32] Newsweek has announced that it will test market a bimonthly, Newsweek Focus, the first issue of which will treat "Mysteries of the Cosmos."[33]

Conclusions about both readership and coverage of science in newspapers and magazines must be regarded as highly tentative, however, because the available data are limited in scope and tend to be out-of-date. Clearly, a new, comprehensive study is needed to guide science writers, editors, and policymakers in improving public understanding of science.

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SOUNDING BOARD

GENE CLONING BY PRESS CONFERENCE

For years many scientists have maintained that science journalists are frequently inaccurate, that they oversimplify, and that in their rush for deadlines and headlines they fail to wait for completion of the orderly processes of scientific review and publication.

In recent months, however, we have begun to witness a reversal unheard of in the annals of scientific communication: the phenomenon of scientists publishing research data by press conference.

It is not entirely clear what is causing this departure from the established norms; however, there is evidence that competition and the increasing involvement of academic scientists in the field of commercial application may be part of the problem. Free inquiry and the pressures of competition associated with the application of technology are not necessarily compatible.

It was Joshua Lederberg — geneticist, Nobel laureate, and now president of Rockefeller University — who anticipated this conflict in a letter to Sen. Gaylord Nelson (D–Wis.): "The possibility of profit — especially when other funding is so tight — will be a distorting influence on open communication and on the pursuit of basic scholarship," Lederberg wrote, adding that most university people disagreed with his views.[1]

The difficulties that prompted Lederberg's warning are clearly demonstrated by recent events involving the reporting of scientific progress in the field of recombinant DNA research. The method of disclosure was not through the accepted channels of scientific communication, but by press conference in which unpublished data were presented by scientists and accepted by the press as valid.

In some instances the academic researchers were individually associated with private companies whose stock gained many points after the public announcements. I see nothing wrong with the scientists' associations or with the stock market. Pecuniary rewards are an important element in our economic system by which capital risks are taken and inventions reach the marketplace to serve the public. But is the press conference the proper avenue for publishing scientific results? And should science reporters give them unqualified coverage?

As a science writer in an academic institution, I have felt bound by the tradition of announcing scientific "breakthroughs" in the lay press only after the work has been published in refereed journals or presented at scientific conferences. Even then I do not always take the author's word about the importance of the work since investigators are likely to be either aggrandizing or self-effacing. I send my manuscripts to key people, whose scientific and medical judgment I respect, for their opinions.

I therefore became concerned when the morning papers of September 7, 1978 announced that scientists at the City of Hope National Medical Center in Los Angeles, and Genentech, Inc., a small research company in San Francisco, had produced "human insulin" using recombinant DNA techniques.[2]

My reaction had nothing to do with the feat itself. The work was the logical extension of the exciting genetic discoveries of the past 20 years, and welcome news. My concern was related to the announcement, which had been made at a press conference without the benefit of prior scientific publication.

It was an unusual method of presenting scientific data. Nevertheless, the story became front-page news everywhere, and was greeted with enthusiasm in both houses of Congress.[3] Rep. Paul Rogers (D–Fla.), now retired, though cautioning the nation's diabetics that it would be years before the process was commercialized, called the achievement "one further example of the pioneering research typical of American science." And Sen. Richard Schweiker (R–Pa.) proudly announced that the National Institutes of Health had shared the research costs.

Buried in the news accounts was a clue to the significance of this news event. Eli Lilly and Company had entered into an agreement with Genentech for eventual commercial application.

Was the insulin story a science "breakthrough" or a business story? Some scientists in the field concede that it was only a step. For one thing, the production of rat insulin had been reported by Harvard scientists a month earlier.[4] "While perhaps not as glamorous as human insulin, one could have written the same story about any number of cloning experiments at the time," a scientist said to me.

Yet journalists reported it as a "breakthrough," failing to ask critical questions that would have helped place the work in perspective. Only Judy Ismach of *Medical World News* got in touch with Dr. William Gartland, director of recombinant DNA activities at the National Institutes of Health.

Gartland told Ismach, "It would have been nice if they had demonstrated biological activity."[5] To claim that one has produced human insulin requires that the gene product must carry out the same functions as it would naturally.

Three months after the City of Hope–Genentech announcement, the insulin work appeared in a scientific report.[6] On the basis of the published data, the insulin was not shown to be functioning biologically.

Less widely noticed, however, was a report of the production of a biologically active mammalian gene product in bacteria, published in *Nature*[7] by Stanford scientists Stanley Cohen, Robert Schimke, and their colleagues. In their experiments, which had been completed and submitted for publication before the City of Hope announcement and had appeared in print several months before the insulin work was published, the Stanford group did not clone a hormone but the enzyme dihydrofolate reductase (DHFR).

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The paper showed that immunologic reactivity is not sufficient evidence that a biologically functioning product has been produced, as immunologists have long recognized. After pointing out that this was the first reported instance in which bacteria were shown able to "synthesize biologically active molecules according to instructions provided by a mammalian biological gene," the Nature-Times News Service commented: "Because bacterial cells can produce biologically active DHFR, they should also be able to produce hormones that will be...therapeutically active." [8]

The Stanford News Bureau took steps to bring all this to public attention. Important work had been completed and published in final form in an established journal, and therefore a carefully worded news release describing how the Cohen-Schimke group had demonstrated synthesis of a biologically active mammalian gene product in bacteria (the enzyme DHFR) was mailed out.

A reporter later called me to say he didn't think the story was really newsworthy.

I asked why. He said the feat had been accomplished previously by the City of Hope in making insulin.

The insulin story and the way it reached the public before it had a chance to become visible through the normal channels of scientific communication is not an isolated example.

Last July a group at Genentech and a competing research group at the University of California in San Francisco sent out press announcements on the same day in an apparent attempt to be credited with the first synthesis in bacteria of "human growth hormone." In the UCSF announcement, the public information office, normally very careful about such matters, did include a statement that the biological activity of the hormone still needed to be tested — an important detail left out in most news reports. Several months passed before either group's work was published in the scientific literature. In neither case, on the basis of the published data, was the product shown to be functioning biologically.[9,10] Under these circumstances, was a public announcement before publication really warranted?

The latest of these extraordinary media events took place on January 16 of this year, when the European-based company Biogen announced in Boston that its scientists had developed clones of interferon-producing bacteria. The claim was widely reported and led to a gratifying boost in the share prices of Biogen's major corporate stockholders.[11]

At the time of the announcement the work had not been published.

Dr. Walter Gilbert, a Harvard professor and chairman of the scientific board of Biogen, and Dr. Charles Weissmann, a professor of molecular biology at the University of Zurich, distributed to reporters a draft of a paper that they said was being prepared for submission to the *Proceedings of the National Academy of Sciences* and that has, as of this writing, not yet been published.

Before the briefing, a seminar in which the scientists described their research apparently was held in the Massachusetts Institute of Technology. But the journalists who were later to receive the Biogen briefing were not invited, thus missing an opportunity to hear how other scientists viewed the work.

One scientist interested in the clinical aspects of interferon, Dr. Thomas Merigan of Stanford University, had difficulty making an assessment. "It is a little hard to know without seeing the data," he told the *Los Angeles Times*. "Until there is a published paper, the results cannot be evaluated, especially with regard to the clinical significance.

"I don't know who is going to publish first," Merigan added. "Many people are trying to copy [in bacteria] the human gene, including researchers in Israel, France, and Japan." [12]

Interferon is being studied as a potentially all-purpose antiviral drug and as a treatment for certain types of cancer. But it is difficult to obtain enough of the substance by conventional methods. The excitement is therefore justified because recombinant DNA technology holds great promise for producing interferon cheaply and in large quantities.

Why didn't the researchers choose the accepted channels for their announcement? One speculation was offered by *Boston Globe* science reporter Richard Knox. He told me that the scientists had applied for a patent. "They feared rumors had already begun to circulate about the interferon work," Knox said.

The *Los Angeles Times* account is more revealing. After quoting Gilbert, who had stated that the Biogen people had attacked the interferon problem using "a brute force" approach, the *Los Angeles Times* said, "Gilbert had, in effect, declared himself a winner of the race." The *Times* alluded to the situation as "the interferon derby." [12]

It is not my purpose here to question the claims or the integrity of any of the scientists engaged in recombinant DNA work. Dr. Weissmann and Dr. Gilbert are highly reputable, respected molecular biologists. Presumably, they would not be staking their professional reputations on this unless they believed they had solid findings. What I am concerned about is the trend that is being established: In place of published data, open to all for examination and critical review, we now get scientific information by press conference. The abrogation by scientists of the normal processes of scientific communication does not help science or the reporters covering it.

No matter how sincere a scientist's belief is that he has accomplished a particular goal, other scientists may view the data differently. Providing a critical analysis of the data from an independent point of view is the function of referees for scientific journals. Press conferences bypass this critical analysis. It is, of course, the journalist's job to publish facts, to call on others to verify claims or obtain different points of

view. But how can other scientists offer reporters informed opinions on the basis of someone's unpublished data? The answer is that they can't. The only notable exception to the reporting of the interferon story was Jerry Bishop's lucid and cautious account in the *Wall Street Journal*.[13] He noted not only that proving interferon's value may take a long time, but also that the bacterium used in the experiment has a nasty habit of producing a protein that is poisonous to humans. Hence, there may be problems in removing the poison from the final interferon product.

There is still another aspect to this question, although not all scientists that I talked to think it is important. Should scientific priority be established by scientific publication or by press conference? The Biogen announcement, as reported in the *New York Times*, said, "The scientists believe the research group was the first to get the gene for interferon into bacteria...."[14] But the feat had already been accomplished by a Japanese research team and published in the *Proceedings of the Japanese Academy* in 1979.[15] In addition, I have been told that at least one other U.S. research group had cloned the gene coding for interferon before the Biogen press conference and is preparing the data for publication.

It seems that the field of recombinant DNA research has become so extremely competitive that some people are tempted to take shortcuts in announcing their results. But their behavior does not contribute to either good science or good science reporting, and it is incumbent on the scientific community as well as journalists to debate this issue widely.

There is also the broader conflict between academic research and the pressure for quick applications that should concern scientists as well as the public.

"It must never be forgotten," said Nobel laureate Arthur Kornberg recently, "that technology rests squarely on a foundation of science. This scientific base is often obscured and ignored when refinements in technology, heaped upon one another, make it seem that marketing is more important than knowledge. In many instances merging of science and technology either in the laboratory or in the funding of research can weaken both.... If this blending is not carefully watched and seasoned to taste, it can eventually destroy them."[16]

News Bureau
Stanford University Medical Center
Stanford, CA 94305

SPYROS ANDREOPOULOS

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Science Writers at Work

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By Sharon Dunwoody

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Edited by G. Cleveland Wilhoit

This report was based on the doctoral dissertation of Professor Sharon Dunwoody of Ohio State University, and was published in December 1978 by the School of Journalism and Center for New Communications at Indiana University, where Dr. Dunwoody was a student in the Mass Communications doctoral program.

Science Writers at Work

Attempts to single out criteria that define news have been going on for some time. But it is only within recent years that investigators have moved away from the search for "universal" criteria that presumably define news consistently across time and events and instead have intensified the examination of news-selection *situationally*. One can no longer be satisfied with determining that certain variables may affect what becomes news in general. The problem arises in that what is elevated to "news status" in one social context may be ignored in another; a particular criterion may be crucial to one coverage event but irrelevant to the next.

The question of "what's news," then, requires a situation-specific answer. One must look for criteria relevant to specific journalists in specific coverage areas.

This study attempts to do just that by examining the effects of two factors on the news-selection behavior of a special group of journalists in a single situation. It gauges the effects of (1) newsroom production pressures and (2) degree of peer interaction on the news selections of science writers at the annual meeting of the American Association for the Advancement of Science (AAAS). The study does so by examining how these two factors affect individual journalists' dependence on AAAS for news selection guidance.

That "guidance" comes in the form of press conferences. One of the largest scientific meetings in the country, the AAAS annual meeting attracts from 300 to 600 science journalists every year. A main goal of AAAS is "to increase public understanding and appreciation of the importance and promise of the methods of science in human progress,"[1] so the institution is interested in attracting as much coverage of its meeting by journalists as possible. Toward that end, AAAS sets up a series of press conferences that continue from the beginning of the six-day meeting to its end. The institution thus makes a conscious and sophisticated effort to determine what becomes news about its own meeting. And the goal of this research was to see how newsroom production pressures and peer status affected the extent to which AAAS actually could "control" news selection decisions of the working press.

The Journalistic Setting

Why were newsroom production pressures and peer status selected from among many potential factors for study? One major reason is that the annual meeting situation provides an excellent "laboratory" for examining these two variables: it is a huge event that offers many stories with "hard news pegs," and it attracts a group of competing specialty writers who have formed some very strong professional and personal associations with one another. Let's define the two factors more clearly:

Newsroom production pressures: The selection of news may be governed by a host of constraints built into a journalist's job. Few reporters are free to cover what they please; among other things, they are limited by deadlines, by knowledge of what competing reporters are doing, and by the amount of equipment (cameras, tape recorders, technicians) needed to do their jobs. Investigators such as Epstein and Tuchman[2] argue that news is largely determined by such mechanical and organizational constraints.

Extent of peer interaction: A number of other researchers, among them Crouse, Tunstall and Chibnall,[3] have found that specialty writers who cover the same news situations often develop intense interactive patterns that include sharing story ideas, notes and information. Although the reporters may be in direct competition with one another, they form close bonds of friendship, and their behaviors in a news-gathering situation are predominantly cooperative.

This seems to be the case with a group of experienced science writers who work for the prestige newspapers, news magazines and wire services in the United States. Since the heyday of the manned space program in the 1960s, these reporters often travel far from their city rooms to cover such national events as scientific meetings, space shuttle tests and the Viking landings on Mars. While remaining autonomous of the newsroom back home, members of this science writing "inner club" are constantly coming into contact with each other on the road. The question for this study was whether participation in this inner club affected a science writer's dependence on AAAS press conferences.

Findings in Brief

Analysis of interviews with science writers, observation of their behaviors at the meeting and content analysis of the resulting stories led to these conclusions:

1. The "average" journalist in the study was highly dependent on press conferences, indicating that AAAS generally could control what became news about its meeting through the press conference structure.

2. Reporters operating under a greater number of newsroom constraints—principally deadlines—were *more dependent* on press conferences than were reporters with few constraints. Thus science writers who anticipated writing few or even no stories from the meeting were more independent of AAAS than were reporters who were expected (by their editors) to produce at least one story a day. Increases in other kinds of job constraints had the same effect. If a reporter felt he was in direct competition with other reporters he depended more heavily on AAAS press conferences than did reporters who perceived less competition. And dependence on AAAS topic selections increased as the number of equipment constraints increased, making broadcast journalists more dependent on AAAS than print journalists.

3. Greater expertise in covering science conversely *decreased* a reporter's dependence on AAAS press conferences. The less a journalist knew about science, then, the more he or she was likely to depend on AAAS to tell him or her what was important.

4. When considered together, findings 2 and 3 meant that the experienced print science writer who came to the meeting with few deadlines was the most *independent* of AAAS, while the broadcast reporter who knew little about science but who had to produce daily stories was the most *dependent* on AAAS.

5. An informal organization—an "inner club"—seems to have evolved to help its "member" science journalists deal with their newsroom deadline and competitive pressures when they are away from the city room without sacrificing the potential benefits of cooperation among each other.

6. Membership in the science writing inner club did not substantially alter a reporter's dependence on press conferences, but it did seem to increase the accuracy and ultimate quality of the stories produced by serving as a large pool of shared resources for members.

Description of the Study

Data for the study were collected in four phases during late 1976 and throughout 1977: (1) a group of inner club and non-inner club science writers was interviewed about their work; (2) the news-selection behaviors of the reporters were observed at the 1977 AAAS annual meeting; (3) all stories about the meeting published in daily newspapers and magazines were content analyzed; and (4) the group of science writers was reinterviewed after the meeting.

The science writers: Twenty-four science journalists were involved in all phases of the study. Of the 24, seventeen were identified as inner club members (see Table 1) and seven as non-members (see Table 2).[4] Because the inner club numbers no more than 25 to 30 altogether, the 17 represent the majority of members in the country and included all inner club members who attended the meeting. The seven non-inner club members were included to provide perspectives on the inner club from persons outside the group.[5]

Phase 1: Prior to the meeting, face-to-face interviews were conducted with the science journalists. The main purpose of the interviews was to obtain self reports from journalists about criteria they use to select newsworthy information, particularly at an AAAS meeting. Additionally, during this phase the investigator interviewed two AAAS officials, one of whom is primarily responsible for organizing the annual meeting and the other for constructing the press conferences. They are, respectively, Arthur Herschman, head of the AAAS Meetings and Publications Division, and Carol Rogers, public information officer.

Phase 2: Four persons trained in observational techniques then attended the 1977 AAAS annual meeting, held 21-25 February in Denver, to observe the science writers on the job. Observers remained primarily in the press area, where most reporters attended the press conferences, wrote and filed their stories, and interacted with one another and with the press officials.

Phase 3: AAAS hires a clipping service to monitor coverage of the annual meeting in all daily newspapers and news magazines in the country. All 772 stories identified by the service through May 1977 were collected and content analyzed with the story as the unit of analysis. Emphasis in the analysis was on the subject of each story, perceived sources of information, and on such characteristics of the newspapers and magazines as size and geographic location.

Phase 4: Following the content analysis, all science journalists in the sample who had covered the meeting were contacted by telephone and asked to discuss in detail their reasons for selecting topics and sources for each story.

Detailed Findings

When covering the meeting, a science writer had four major information sources at his disposal: news conferences, symposia, individual interviews with scientists, and research papers. Heavy use of press conferences would indicate a high degree of dependence on AAAS for selection guidance, while use of the other three sources would indicate a selection process more independent of AAAS.

Additionally, a science writer could vary the number of sources he or she would use for any single story. In this analysis stories will be classified as single-source, double-source or multiple-source (three or more sources) stories.

The information-selection behaviors of the 19 journalists are first examined as a group. Then the writers are divided into those with daily deadlines (14 reporters) and those with few or no deadlines (5) to examine the constraints question, and into inner club members (14) and outsiders (5) to look for effects of peer status on news selections.

The "composite" science writer: The average science writer in this study wrote more than one story a day during the six-day meeting (see Table 3). He produced either single-source or two-source stories, and more of his stories utilized press conferences than any other source.

Stories utilizing more than two sources were rare; in fact, nearly half of all the stories written by the 19 respondents were single-source stories, while another 41 percent of the stories were produced from only two sources.

Of the single-source stories, press conferences accounted for 40 percent, more than any other single source.

In sum, the "average" journalist in this study managed to file at least one story a day by limiting the number of sources he used for each story to one or two and by utilizing the available press conferences more heavily than any other source.

Our composite journalist was quite prolific and indeed seemed to be dependent to some degree on press conferences as sources of information. But was that dependence related to either of the factors being examined in this study?

Newsroom constraints: Number of constraints proved to be the best predictor of dependence on AAAS. Three types of constraints will be examined briefly here: number of deadlines, the pressures of competition, and equipment requirements.

1. Deadline pressures. The more stories a reporter was expected to write, the more likely he was to rely on the press conferences as an efficient means of gathering information. In fact, there is a startling difference between the number of press conferences attended by constrained reporters and the number attended by reporters with few constraints (see Table 3). Similarly, the "average" constrained science writer utilized press conferences as story sources far more often than any other source, while reporters with few or no deadlines were more likely to have gone to a meeting symposium or obtained an interview with the scientist.

The number of constraints under which the reporter operated also seems to have been the major factor governing the number of sources used for a story. More than 50 percent of the stories produced by reporters with daily deadlines were single-source stories, while the majority of stories written by the less constrained journalists used two sources. Constrained reporters did very few multiple-source stories, but less constrained reporters were more likely to write stories utilizing more than two sources than they were to do single-source stories.

Thus daily deadlines seemed to force reporters into a single-source or double-source story pattern that in turn mandated dependence on the press conference structure. When time was of the essence, press conferences offered an efficient means of gathering information in a large meeting setting. One respondent noted that "you'll find some people—myself sometimes included—who go to nothing but press conferences" because sitting through meeting symposia can "waste an awful lot of time. Press conferences are vital. If you've got to produce a story every day, that's the way you're going to get it."

2. Competitive factors. Competition proved to be another constraint that increased dependence on press conferences. As members of the prestige press, inner club members particularly are each other's main competition. They know their editors are gauging the quality of their work on the basis of what the competition is doing, and if the *Boston Globe* and the *New York Times* science writers each write different stories on a given day, they leave themselves open to accusations from their city rooms that they somehow "missed" a story that the other reporter obtained.

Even editors on less prestigious newspapers will tend to define "good" coverage of scientific events on the basis of what comes over the AP or UPI wires; thus the ultimate quality of a science writer's coverage (in the eyes of her newspaper) may be largely dependent on how closely she follows the leads of the wire service reporters.

Science writers can minimize complaints from their city rooms, then, not by doing different stories but by *duplicating* each other. And press conferences provide the best means of doing this. If all journalists cover the same event in the same room and write essentially the same story, there's no question about whether one "got" the story for that day. Reporters, using press conferences, have *created* the story for the day *en masse*. One inner club member explained the situation succinctly:

> I go to a press conference because I don't want to be surprised the next day by seeing that somebody else picked up a big story that I missed. I know what newspapers my editors watch, too. If (the competition) files a story, I want to be sure I don't get a call the next day (from the desk wondering) why I didn't write it. I know that they've seen the wires and I'm out there (at the meeting). So there's a bit of self protection.

3. Equipment constraints. Observational data indicated that, while the print reporters with few deadlines were most independent of AAAS, the broadcasting reporters, who were saddled not only with deadlines but also with equipment constraints, were most dependent on AAAS to tell them what to cover. Local television and radio reporters were frequently observed asking AAAS personnel to give them "a couple good ideas" for

stories for the next day. If a broadcast reporter had isolated a story topic, then he or she often would ask AAAS to find an appropriate scientist to talk about it.

Peer Interaction: Inner club affiliation seemed to have little effect on a science writer's dependence on press conferences. Inner club members were under the same daily deadline constraints as were outsiders, and production of daily stories made them just as dependent on press conferences (see Table 3). The only difference in source usage seemed to be that inner club members, when writing single-source stories, were just as likely to use scientific papers as they were press conferences, while nonmembers relied primarily on press conferences and secondarily on interviews for their single-source stories.

So whether or not you were an inner club member made little difference in your dependence on AAAS for story selection guidance, because everyone relied on the press conferences. Club membership did seem to have an effect, however, on the accuracy and overall quality of stories produced. For all practical purposes, the inner club at an event like the AAAS meeting serves its members as a large pool of resources. Inner club reporters can share information, provide each other with technical definitions and can warn each other away from suspicious sources and unsubstantiated research reports.

In one instance at the meeting, for example, an inner club member came away from a press conference about the Martian moon Phobos with the idea that the tiny moon harbored huge reserves of oil. Other club members quickly checked out that possibility and warned their colleague that this conclusion was not substantiated by the research presented. The reporter subsequently downplayed the potentially misleading "little Saudi Arabia" theme in his story.

Thus access to the expertise of other science writers—one benefit of the inner club—may not have a substantial effect on a reporter's dependence on press conferences but may indeed affect his or her ability to be critical of the scientific information presented in those press conferences.

Extent of scientific knowledge did increase independence from AAAS selections, and this is best illustrated with broadcast reporters. Both local and national broadcast media covered the event, but AAAS personnel were able to exercise much greater control over local reporters than over the network and National Public Radio crews. Since equipment constraints for all broadcasters were similar, the major difference seemed to lie in scientific expertise. Few broadcast reporters in this country have extensive science knowledge, and those who do are likely to work for national media. Thus local radio and television reporters, who knew little about science and who had virtually no access to the opinions of science writers covering the meeting, were almost completely dependent on AAAS for topic suggestions. For this group, then, what's news was literally up to the institution itself.

Why does the inner club exist? All journalists must deal with the kinds of newsroom pressures described above. But few find themselves in the conflicting positions of the experienced science writers in this study.

To cover their beats, science writers for the prestige publications must often leave their city rooms, fly to other parts of the country and cover stories for days or weeks at a time. Under these conditions, their constant companions are science writers from other prestige newspapers. A reporter lives and writes in the lap of his or her main competitors.

Additionally, the reporters are faced with the task of translating difficult technical material into lay language and must deal with sources (scientists) who are wary, sometimes ill-prepared to talk to journalists, and who are likely to be very critical of the journalistic product.

The result is that science writers band together on the road; a journalist's main competitor becomes his best friend. As one inner club member noted:

> We see more of each other because of going to these meetings, covering these stories. You're with each other for several days at a time, most of the day and most of the evening; you tend to go out and eat dinner together. So you get to be very good friends. You've got a common interest. . . I have more in common with science writers from other papers than I do with reporters here on the ——, because we're covering the same stories, we interview the same people, and we see each other not just casually. So we all get to be pretty good friends.

The contradiction lies in that these "friends" must also respond to the organizational and competitive requirements of their own editors, who view competing science writers as opponents, not as friends.

The inner club seems to have evolved in part as a way of dealing with this opponent/friend contradiction. The group has its roots in the manned space program of the 1960s, when the reporters suddenly found themselves appointed science writers and were sent to Cape Canaveral and Houston to cover one of the most exciting stories of the decade.

One writer who places the genesis of the club with the space program described it in this way:

> At the height of it, they were making a major launch every three months, and you would be down there at the Cape for two and a half weeks at a time. The result was that it (the group of science writers) became your family. There were love affairs, there were hates and fights... It became a traveling road show with the same people showing up time and time again, going to the same places and doing the same things. There was great cohesiveness.

The club serves as a means of accommodating the various conflicting pressures encountered by science writers away from the city room by promoting cooperation among members rather than competition. By sharing ideas and information, the science writers can more efficiently meet their deadline demands and at the same time can reduce the potential for being scooped.

Efficiency is increased because the journalists are working together, using each other as sounding boards for story ideas, sharing information from interviews at the writing stage, helping one another with definitions and concepts.

The club reduces competitive tensions through the same sharing mechanisms. One neutralizes competition not by scooping one's colleagues but by duplicating news judgments. So the cooperative aspect of the club facilitates such duplication.

By turning what should be a highly competitive situation into a highly cooperative one, then, the club allows the science writer to meet the demands of his or her city room without sacrificing the strong personal and professional relationships that have developed among colleagues on the road.

Table 1

Inner Club Members Interviewed

Name	Title	Affiliation
George Alexander	Science writer	*Los Angeles Times*
Jerry Bishop	Staff reporter	*Wall Street Journal*
Bob Cooke	Science editor	*Boston Globe*
Ed Edelson	Science editor	*New York Daily News*
Peter Gwynne	Science editor	*Newsweek*
Don Kirkman	Science writer	Scripps-Howard Newspapers
Ron Kotulak	Science editor	*Chicago Tribune*
John Langone	Medical editor	*Boston Herald-American*
Tom O'Toole	Science editor	*Washington Post*
David Perlman	Science editor	*San Francisco Chronicle*
Judy Randal	Science writer	*New York Daily News*
Joann Rodgers	Medical writer	Hearst Newspapers/*Baltimore News-American*
Al Rossiter	Science editor	United Press International
Joel Shurkin	Science writer	*Philadelphia Inquirer*
Brian Sullivan	Science writer	Associated Press
Walter Sullivan	Science editor	*The New York Times*
Pat Young*	Science writer	*The National Observer*

n = 17

*Since the demise of *The National Observer* in July, 1977, Young has worked as a free-lance science writer in the Washington, D.C. area.

Implications

This study was conducted primarily to examine criteria that control "what's news" about a large scientific meeting. The overwhelming answer seems to be: the institution itself. AAAS can dictate what becomes news about its own meetings to a great degree simply by offering particular topics in press-conference formats.

The reason *why* this is the case, however, should be of more immediate interest to practicing journalists. AAAS is successful because it caters to a set of selection criteria that dominates the information-selection process at the meeting: *newsroom production pressures*. The more deadlines, competitive pressures and equipment restraints the journalist is saddled with, the greater the degree of "control" by AAAS over its own news coverage.

Additionally, the less a reporter knows about science, the more successfully AAAS can dictate what's news.

Thus the journalist in such a meeting situation seems to lose control over the information-selection process *as the number of traditional demands placed on him by the city room increase*. One way, then, of putting control back into the hands of the journalist would be to decrease those demands. Four recommendations would have that effect:

1. Many editors who allow their reporters to cover events away from the city room expect a return on their travel investment in terms of sheer numbers of stories. But by eliminating deadline pressures, editors may give their reporters room to make independent news judgments. Rather than expecting a story or two a day from an event like the AAAS annual meeting, editors could instruct their journalists to write a story when something worth writing about takes place and to spend the rest of the time gathering information and making contacts for future stories.

2. Competition is something of a sacred cow in journalism, but it becomes counterproductive when it reinforces the kind of "mass" coverage of the same events (press conferences) found at meetings. The newspaper science writer covers the same press conference and writes the same story as the AP science writer, for example, because he knows his editor is defining "good" coverage of the meeting in terms of what the wire services are producing.

One alternative would be to regard the presence of more than one reporter as a supplementary rather than competitive situation. This would work only if an editor stopped evaluating the quality of his reporter's choices on the basis of what others choose and instead assumed that his reporter can and will apply some reasonable criterion to the selection process. If the competing newspaper publishes a story on a different topic, then, the editor would not conclude that his reporter had "missed" a story but rather that there were many rational topic choices available at the meeting.

3. It is clear from this study that the more a reporter knows about the topic he is covering, the more control he will be able to exercise over the information-selection process in situations

Table 2

Younger Journalists Interviewed

Name	Title	Affiliation
Ira Flatow	Science reporter	National Public Radio
Jon Franklin	Science writer	*Baltimore Sun*
Bob Gillette	Science writer	*Los Angeles Times*
Elizabeth Maggio	Science writer	*Arizona Daily Star*
Cristine Russell	Science/medical writer	*Washington Star*
David Salisbury	Science writer	*Christian Science Monitor*
Michael Woods	Science editor	*Toledo Blade*

n = 7

Table 3

The "Average" Journalist's Performance During the AAAS Meeting: Mean Values on a Number of Production/Source Variables

		Status		Constraints	
	All (n=19)*	Inner Club (n=14)	Other (n=5)	Many (n=14)	Few (n=5)
Mean number of stories	6.5	6.5	6.4	7.6	3.4
Mean number of press conferences attended	6.4	6.5	6.0	7.7	2.6
Mean number of stories utilizing:					
Press conference	2.8	2.8	3.0	3.4	1.2
Symposium	1.3	1.2	1.6	1.1	1.8
Paper	2.4	2.6	1.8	2.9	1.0
Interview	2.6	2.3	3.6	2.8	2.2
Single Source	3.0	3.0	2.8	3.8	.6
Two sources	2.5	2.6	2.2	2.8	1.8
Multiple sources	.7	.5	1.2	.6	1.0

*n's indicate number of respondents in the respective subgroups.

like the AAAS meeting. Such a finding argues for specialty writers in the mass media, for persons who can maintain enough expertise in a content area to make independent news judgments possible. Broadcast operations have even fewer specialty reporters than do print media, but if this study is any indication, this lack of specialists may cost them dearly in terms of their ability to control information selection in situations like the AAAS meeting.

4. The media have traditionally viewed cooperation between competing reporters rather negatively; the term "pack journalism," for example, is one negative label often applied to the concept. And to the extent that cooperative behavior promotes rampant homogeneity in story selections, criticism is warranted.

But when information in a field is highly technical, when one reporter simply cannot bring enough expertise to the job to perform effectively at all times, then cooperative behavior could be highly beneficial.

The science-writing inner club sanctions cooperative behavior, its members argue, precisely *because* scientific information is so difficult that reporters can do their jobs better if given access to other reporters. Noted one inner club member:

> As a whole, science writers are less competitive than other kinds of writers. That's my assessment... By and large I've always had a sense among my colleagues that we have more of a community interest in promoting science news accurately and fairly, if not uniformly.

If one can argue that cooperation indeed benefits science writers, then it would seem that such behavior could benefit other reporters as well. Traditionally, journalists perceive themselves as loners, one individual against the competition. This study suggests that in a field where concepts are complex and where it is difficult for one individual to understand the entire subject field (in short, most fields), reporters and readers may gain much from cooperative behavior.

Notes

[1] Margaret Mead, "Towards a Human Science," *Science* 191:903-909, 5 March 1976, p. 909.

[2] Edward J. Epstein, "News From Nowhere," in Gaye Tuchman, ed., *The TV Establishment: Programming for Power and Profit* (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1974) pp. 44-52; Gaye Tuchman, *Making News: A Study in the Construction of Reality* (New York: Free Press, in press).

[3] Timothy Crouse, *The Boys on the Bus* (New York: Ballantine Books, 1973); Jeremy Tunstall, *Journalists at Work* (London: Constable, 1971); Steve Chibnall, *Law-and-Order News* (London: Tavistock Publications Limited, 1977).

[4] To isolate those mass media science journalists who make up the inner club, three newspaper science writers who have held leadership positions in the National Association of Science Writers, Inc., and four public information persons who, through their work for large scientific institutions, come into regular contact with the inner club were asked to list journalists who they felt were inner club members. Providing lists were David Perlman, then-science editor of the *San Francisco Chronicle*; Ed Edelson, science editor of the *New York Daily News*; Ron Kotulak, science editor of the *Chicago Tribune*; Don Phillips, American Hospital Association; Audrey Likely, director of public relations for the American Institute of Physics; Dorothy Smith, manager of the news service for the American Chemical Society; and Carol Rogers, AAAS public information officer. The lists were merged and the journalists ranked according to the number of times they were mentioned. Those named by four or more persons were considered the most likely candidates for inner club status, and interviews were obtained with all such individuals who indicated they were likely to attend the AAAS meeting.

[5] The non-inner club respondents were ranked by three or fewer persons on the list, they too planned to attend the AAAS meeting, and most of them worked for media comparable in size and prestige to those employing inner club reporters.

[6] AAAS subscribes to the Washington-based Press Intelligence, Inc.

[7] These data are not discussed in this report. Details of the content analysis are available from the author upon request.

[8] Of the 24 journalists in the sample, five did not attend the meeting for various reasons. They were David Perlman, *San Francisco Chronicle*; Joel Shurkin, *Philadelphia Inquirer*; Jerry Bishop, *Wall Street Journal*; Michael Woods, *Toledo Blade*; and Bob Gillette, *Los Angeles Times*.

SUGGESTED READING LIST

Compiled by William R. Kell, Editor
Robert J. Fauteux, Associate Editor
David S. Miller, Assistant Editor
Research, University of Minnesota

BOOKS ABOUT RESEARCH FOR THE GENERAL AUDIENCE

Bernstein, Jeremy. Experiencing Science: Profiles in Discovery. E.P. Dutton (paperback). 1978.

With the grace of an essayist and the perspective of an insider, Bernstein tells stories of several scientists from Kepler to Lewis Thomas, digresses on the fantasies of Arthur Clarke, and concludes with a love story involving Bertrand Russell and Gödell's theorem.

Darwin, Charles. The Voyage of the Beagle. E. P. Dutton (paperback). 1980.

Less approachable than the TV version but easier than the Origin. Darwin was able to assume that first-rate science would have an audience among all educated persons, not just because his research was adventurous, but because his data and conclusions would change the way all of his readers looked at the world.

Feinberg, Gerald. What Is the World Made of? Atoms, Leptons, Quarks, and Other Tantalizing Particles. Anchor Books (paperback). 1978.

A lucid presentation of what is known and what remains baffling to contemporary physicists. Feinberg is enthusiastically endorsed by Bernstein and Weinberg.

Gardiner, Martin. The Relativity Explosion. Vintage (paperback). 1976.

Gardiner writes a puzzle and game column for the Scientific American, and is the author of a number of accessible books on physics and mathematics. This one explains black holes, quasars, and other astronomical marvels that are helping to solve the greatest puzzle of all, Einstein's theory.

Janovy, John, Jr. Keith County Journal. St. Martin's Press (paperback). 1978.

A biology professor and watercolorist, Janovy writes with a flexible style ranging from earthy to ironic to orotund. He makes the details of life among snails, intestinal worms, and marsh wrens more entertaining than the sins of the Ewings.

de Kruif, Paul. Microbe Hunters. Harcourt, Brace, Jovanovich (paperback). 1966.

Originally published in the 1920s, this story of the things that make us sick and the men who discovered them is an enduring, if somewhat archaically written, classic of science writing.

Paz, Octavio. Claude Levi-Strauss: An Introduction. Dell (paperback). 1974.

Paz is a Mexican poet and former ambassador who has mastered the intricacies of Levi-Strauss's "science of mythology" and translated them into language not only accessible but stunning.

Sagan, Carl. The Dragons of Eden: Speculations on the Evolution of Human Intelligence. Ballantine Books. 1978.

Weaves together research data on brain anatomy, sleep and dreams, fossil evidence of human origins, Greek and Biblical mythology, and more. Sagan, a prolific writer on the subject of everything, soars where specialists tread lightly or not at all. Yet he is credible, and makes current knowledge not only understandable but irresistible; he puts it in the service of answering basic questions about who we are, where we come from, and where we ought to be going.

Scheffer, Victor. The Year of the Whale. Scribner (paperback). 1969.

A wildlife biologist who specialized in sea mammals, Scheffer adopted the animal story to the purpose of telling readers most of what there is to know about whales. The resulting narrative is both moving and precise.

Silk, Leonard. The Economists. Avon (paperback). 1978.

A study of five contemporary economists laying bare, for the lay reader, the fault lines in the foundations of the discipline. The "dismal science" has other literate interpreters, of course, notably Robert Heilbroner, whose The Worldly Philosophers (Simon and Schuster, paperback, 1964) is a witty survey of economists before the present.

Simpson, George Gaylord. The Major Features of Evolution. Simon and Schuster (paperback). 1967.

The author is a paleontologist, geologist, and traveler whose books rest as easily on the scholar's desk as they do on the coffee table. In this work and The Meaning of Evolution (Simon and Schuster, paperback, 1967) he surveys his scholarly field and lets the lay reader in on the story. He has also written well about various kinds of fossils, penguins, and himself.

Steen, Lynn Arthur, editor. Mathematics Today. Random (paperback). 1980.

One critic calls it "a rarity: a first-rate popular book about modern mathematics." Includes essays on computers, the geometry of space and time, weather-forecasting, and the insolubility--even by computers--of certain problems.

Steinbeck, John. The Log from the Sea of Cortez. Penguin (paperback). 1977.

Steinbeck was an enthusiastic amateur biologist. This book tells the story of his service as a helper gathering specimens on a research voyage with a man who was the model for a character in Cannery Row.

Watson, James. The Double Helix. New American Library (paperback). 1969.

The witty and unsparing reminiscence of how the structure of DNA was discovered. It tells all the details of the intellectual adventure that got left out of the scientific report. Watson's treatment of one investigator, Rosalind Franklin, (he admitted the shabbiness of his behavior), spawned a rebuttal: Rosalind Franklin and DNA (Anne Sayre, Norton, hardback, 1978). Comparing the two, one can see that the personal adventures of the investigators are part and parcel of the discovery process. A more thorough treatment is The Eighth Day of Creation: The Makers of the Revolution in Biology (Horace Freeland Judson, Simon and Schuster, hardback, 1979).

Weinberg, Steven. The First Three Minutes: A Modern View of the Origin of the Universe. Bantam Books (paperback). 1977.

Lucidly explains the experimental evidence that makes scientists (Weinberg is one) able to say, with some confidence, that the universe began with a Big Bang.

BOOKS ABOUT RESEARCH COMMUNICATION

Dixon, Bernard. What Is Science For? Harper & Row (paperback). 1973.

A reporter with scientific training dissects the scientific community. Especially good on the structure of scientific articles and the relationship of that form of writing to the scientific view of reality.

Goodell, Rae. The Visible Scientists. Little, Brown (hardback). 1977.

A science-writing scholar looks at scientists in many disciplines who have learned to use modern journalism to shape public beliefs about science, e.g., B.F. Skinner, Carl Sagan, Barry Commoner, William Shockley.

Green, Martin B. Science and the Shabby Curate of Poetry: Essays about the Two Cultures. Greenwood (hardback). 1978.

An excellent but eccentric collection of essays on the gulf between the sciences and the humanities, including a first-rate discussion of the popularization of science.

Latour, Bruno and Steve Woolgar. Laboratory Life: The Social Construction of Scientific Facts. Sage Publications (paperback). 1979.

An anthropological report on two years of field-work studying the culture of laboratory life to determine how science constructs order out of the raw disorder of observation.

Mills, C. Wright. The Sociological Imagination. Oxford University Press (paperback). 1967.

Mills, a sociologist who was "visible" during his career, interprets the place of the social sciences within the humanities, "the proper study of mankind." An appendix provides the sociological equivalent of a laboratory manual. Especially good--and witty--is his analysis and translation of some of sociology's more impenetrable rhetoric.

Shahn, Ben. The Shape of Content. Harvard University Press (paperback). 1957.

With clarity and eloquence the American painter analyzes art and demonstrates that it, too, can be discussed in the mother tongue. In explaining his own works, he provides a model for other artists and critics. Good on the relationship of style, form, and content in all communication.

Wilson, David Scofield. In the Presence of Nature. University of Massachusetts Press (hardback). 1978.

A critical study of the lives and writings of three contributors to 17th century science, with detailed attention to the evolution of scientific style in England and America from those days up to our own.

ARTICLES ABOUT RESEARCH COMMUNICATION

Bernstein, Jeremy. "From Quarks to Cosmos." The New Yorker. October 8, 1979. "Popular Science." The New Yorker. September 19, 1977.

Bernstein, a scientist and a regular book reviewer for The New Yorker, here gives an overview of the field of science writing and a list of his favorite examples.

Campbell, Paul Newell. "The Personae of Scientific Discourse." Quarterly Journal of Speech. Vol. 61, December 1975.

A professor of theatre argues that science writing is rhetorical and that the persona created by the writer is important to the effectiveness of the argument.

Dunwoody, Sharon. "Research Report No. 7--Science Writers at Work." Center for New Communications Research Reports, School of Journalism, Indiana University, Bloomington. 1978.

A study of who decides what news is fit to print in a particular situation: an annual AAAS meeting. Dunwoody concludes that AAAS press conferences decide in most cases, especially for reporters with tight deadlines. Reporters with good science training and flexible deadlines see more sources, read more articles, and write better science news.

Funkhouser, G. Ray and Nathan Maccoby. "Tailoring Science Writing to the General Audience." Journalism Quarterly. Summer 1973.

The authors derive practical rules for effective science writing based on surveys of readers.

Grunig, James E. "Research on Science Communication: What is Known and What Needs To Be Known," ACE Quarterly. Vol. 62, No. 4, October - December, 1979.

A survey of the literature aimed toward developing a general theory of science communication.

Hamilton, David. "Writing Science." College English. Vol. 40, No. 1, Summer 1978.

A teacher of what he has come to call "writing science" explains, with some help from Heidegger, the relationship between good writing and complete understanding. Includes a deft swat at the reigning king of the science essay, Lewis Thomas.

Ritterbush, Philip C. "The Public Side of Science: Science and the Democratic Commitment." Change. September, 1977.

In a historically framed argument, the author blames inadequacy of science communication on the elitist belief that the public needs no knowledge; experts will run things for us. Hence, he advocates formation of Regional Communications Systems to provide information to democratically organized groups, such as those working to restore the natural environment.

Ryan, Michael. "Attitudes of Scientists and Journalists Toward Media Coverage of Science News." Journalism Quarterly. Vol. 56, No. 1, Spring 1979.

Surveys show the extent of disagreement between scientists and reporters on how well science is covered and how it should be covered.

FOR ADDITIONAL READING . . .

The following items come from annotated bibliographies published in Sciphers, a quarterly newsletter published by the Science Writing Educators Group for teachers of science writing and others interested in science communication. The newsletter is available for $8 a year from the School of Journalism, University of Missouri, Columbia, MO 65201. Co-editors are Sharon Dunwoody of Ohio State University and Joye Patterson, UM.

Armstrong, J. C. "Does Unintelligible Research Mean High Prestige?" Society for Social Studies of Science Newsletter 4:3-4, Summer 1979.

Armstrong has conducted several studies in an attempt to test the hypothesis that unintelligible writing in science does more for the scientist's reputation than does clear writing. The studies, briefly described in this short article, all support his hypothesis. A more complete description of his work is available: J. Scott Armstrong, "Unintelligible Research and Academic Prestige: Further Adventures of Dr. Fox," Department of Marketing Working Paper, Wharton School, University of Pennsylvania, Philadelphia, PA 19104.

Barclay, William R. "Science Reporting to Alarm the Public." Journal of the American Medical Association 242:754, 24/31, August 1979.

The author, JAMA editor and an MD, argues that government agencies are not as careful validators of science as are journals. Agencies sometimes release questionable research that is then picked up by media, and the resulting publicity can be distorting. As an example, he cites information released by HEW stating that reserpine, a drug used for control of hypertension, was carcinogenic. When the full research report was issued later, Barclay felt it did not contain data justifying the charge. He suggests that editors of major medical journals organize a task force to respond to prematurely issued reports and to advise journalists when such cases arise.

Carlisle, E. F. and Kinsinger, J. B. "Scientific Writing--A Humanistic and Scientific Course for Science Undergraduates," Journal of Chemical Engineering 54:632-634, October 1977.

The authors outline a year-long course they developed and taught on an experimental basis at Michigan State University through the cooperation of the English, chemistry and physics departments. This article mentions course emphases, the texts used and some of the actual writing exercises assigned. In general, the experiment seems to have been a successful interaction between humanistic and scientific departments.

Crichton, Michael. "Medical Obfuscation: Structure and Function." New England Journal of Medicine 293: 1257-1259, 11 December 1975.

Crichton feels that "medical writing in general is weak." To bolster his case, he analyzed the prose from three 1975 issues of the New England Journal of Medicine and then describes the 10 most

common faults. Scoring the highest in frequency was poor flow of ideas from sentence to sentence. He feels that such complex writing is not accidental; rather, obfuscation has become a game that scientists must play. In fact, he argues, it may be dangerous not to play. "This may explain why only the most eminent physicians . . . feel free to express themselves lucidly," he writes. "They are above attack."

Dunwoody, Sharon. "The Science Writing Inner Club: A Communication Link Between Science and the Lay Public." Science, Technology and Human Values 5:14-22, Winter 1980.

The author argues that a relatively small group of prestigious science journalists plays a dominant role in determining what the public sees about science in media. She discusses the genesis of the group and outlines the advantages and disadvantages of such a coalition.

Garfield, Eugene. "Science on Television." Current Contents (Life Sciences) 1980:5-10, 5 May 1980.

The wealth of new science shows now appearing on both commercial and public networks is detailed in this article.

Gladstone, Jo. "Commentary: Remarks on the Portrayal of Scientists." Science, Technology and Human Values 5:4-9, Summer 1980.

The article briefly examines the documentary film genre as a vehicle for portraying scientists realistically. Gladstone is executive producer of the Public Affairs Division of WGBH-TV, Boston.

Gubanich, A. A. "Writing the Scientific Paper in the Investigative Lab," The American Biology Teacher 39:27-34, January 1977.

Gubanich found that college students had difficulty writing scientific papers for a laboratory course, so he prepared a handout discussing the rationale and format of the traditional scientific research report. The guide, printed in this article, is simple, easy to read, and would be a big help to journalism students who are encountering their first scientific papers in a science writing course.

Hunsaker, A. "Enjoyment and Information Gain in Science Articles," Journalism Quarterly 56:617-619, Autumn 1979.

In an experimental setting, the author compared reader enjoyment and information gain among subjects who read one of three versions of a psychology journal article. The three articles varied in language simplicity. Findings indicated that while reader enjoyment increased as the writing became more popularized, information gain remained the same. He concluded that science can be written in a form that lay people would enjoy without sacrificing the amount of information presented.

Jones, G. and Meadows, A. J. "Sources and Selection of Scientific Material for Newspapers and Radio Programs," Journal of Research Communication Studies 1:69-82, 1978.

The authors examined nearly 200 items selected by two BBC radio departments for science programs over a period of several months and also interviewed a number of science journalists about their sources of news. Among their findings are that formal sources of information for science reporters are limited in number and "not necessarily representative of scientific research as a whole."

Kemeny, John G. "Saving American Democracy: The Lessons of Three Mile Island." Technology Review 83: 65-75, June/July 1980.
The chairman of the President's Commission on the Accident at Three Mile Island reflects upon some of the experiences that took place during the six-month investigation and on the implications of the accident for America's future. The article contains some of his feelings (mostly negative) about media coverage of the accident and, particularly, about coverage--or the lack of it--of the commission's findings.

Lurie, Joan. "Science Communication in the Mass Media." Cosmic Search 2:39-40, Summer 1980.
The author summarizes the messages of a panel of science journalists and scientists who discussed "New Initiatives in Science Communications" at a meeting of the American Physical Society. Panelists included New York Times science writer John Nobel Wilford, who discussed the Tuesday "Science Times" section; Leon Jaroff of Time magazine, who talked about the Time science magazine, Discover; physicist G. F. Wheeler, who talked about the process of creating "3-2-1 Contact," PBS's science program for children; and David Kalson of the American Institute of Physics, who discussed AIP's attempts to market 90-second science "spots" to commercial television stations.

"Popular Reporting of Agricultural Science: Strategies for Improvement." Proceedings of the National Agricultural Science Information Conference, Iowa State University, Ames, Iowa, 22-26, October 1979.
This conference offered papers and talks on a wide range of science communication topics. Included are remarks on the process and problems of science communication by scientists, farmers, science writers and consumers. Copies of the proceedings are available free of charge by writing to Mason Miller, Office of the Deputy Director for Cooperative Research, Science and Education Administration, U.S. Department of Agriculture, Washington, DC 20250. In addition, papers from the conference have been printed in the October/December 1979 issue of The ACE Quarterly (volume 62, no. 4).

Rubin, D. "Science Writers Never Had a Chance in the Three Mile Island Nuclear Debacle," NASW Newsletter 28:1-2, 10-13, January 1980.
Rubin, who headed the Task Force on Public Information for the President's Commission on the Accident at Three Mile Island, argues in this article that science writers were not well served by their information sources. Although many reporters covering the accident were not science writers, some were. But Rubin says that these people often were no better off than generalists, since Metropolitan

Edison's personnel and other public information officials sometimes avoided all journalists, offered no support services and few official spokespersons. In some cases public information officials deliberately chose not to cater to specialty writers who knew what they were doing. Said one official, the Nuclear Regulatory Commission was reluctant to set up special technical briefings for science writers for fear of offending those reporters not invited. Consequently, says Rubin, science writers had no opportunity to perform a "pivotal role" by helping less skilled reporters gather the correct information.

Schoenfeld, A. C. "The Changing Role of Mass Communication in Environmental Education," The Journal of Environmental Education 8:60-64, Spring 1977.

This article provides a brief but fascinating history of the relationship between mass communication and environment. It also poses the notion that the National Environmental Policy Act, passed in 1969, has done more to make environmental issues fit into "news" criteria than any other event.

Schoenfeld, A. C. "The Press and NEPA: The Case of the Missing Agenda," Journalism Quarterly 56:577-585, Autumn 1979.

The author looks in vain for media coverage of the National Environmental Policy Act during the legislation's birth and passage in 1969. He concludes that most media--even the specialized environmental press--paid no attention until after the landmark legislation made its presence known through environmental impact statements. In this case, he argues, media failed to set the public agenda.

Tagliacozzo, R. "Some Stylistic Variations in Scientific Writing," Journal of the American Society for Information Science 29:136-147, May 1978.

The author is interested in identifying some characteristics of written scientific language that may be used to differentiate levels of technicality. By comparing Scientific American articles with related articles published in scientific journals, she found that the journal articles used fewer "function words" (articles, conjunctions, adjectives, prepositions, pronouns) than did articles written for a more general public. She also found that the journal articles were more likely to use nouns as adjectives, as in "head movements, rather than "movements of the head."

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OTHER RESOURCES

Friedman, Sharon M., Goodell, Rae, and Verbit, Lawrence. Directory of Science Communication Courses and Programs. State University of New York at Binghamton, 1978.

The Directory lists by state those science communication courses and programs that appear to teach science communication aimed at the general public. It lists and describes 34 programs and 105 courses offered by 58 colleges and universities, including program or course title, focus and scope, enrollment, predominant majors enrolled, average number of students, and instructor. It does not evaluate the offerings. Available for $4.95 from the Department of Chemistry, State University of New York at Binghamton, Binghamton, NY 13901.

"1981 Directory of Journalism Awards and Fellowships." Editor and Publisher, December 27, 1980.

The listing describes regional, national, and international competitions, prizes, awards, fellowships, and scholarships for journalists, reporters, columnists, editors, cartoonists, and photographers. Listed by subject area, the competitions include several relating to communicating scientific information in such areas as health, physics/astronomy, psychology, speech/language, nutrition, economics, engineering, and environment/energy.